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COMMONWEALTH BUREAU OF METEOROLOGY,
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THE CLIMATE AND METEOROLOGY OF AUSTRALIA.

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CHAPTER IV.

CLIMATE OF AUSTRALIA.

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CHAPTER IV.

CLIMATE OF AUSTRALIA.

By H. A. Hunt, F.R.Met.S., Commonwealth Meteorologist.

SYNOPSIS.

1. INTRODUCTION.
2. THE SEASONS.
3. TEMPERATURE.
4. FROSTS.
5. RAINFALL.
6. NORMAL MONTHLY DISTRIBUTION OF RAIN.
7. WETTEST MONTHS.
8. RAINFALL DURING THE WHEAT-GROWING PERIOD.
9. SNOW.
10. EVAPORATION.
11. BAROMETRIC PRESSURE.
12. WINDS.
13. SOUTHERLY BURSTERS.
14. HURRICANES.

1. Introduction.

Until recent years Australia was regarded by most people as a land especially subject to severe droughts, and by more generous critics as a land of a feast or a famine.

Similar misconceptions of the true character of the country have to a greater or less extent been held in the developmental stages in the early histories of most lands, and in the colonization of newly discovered territories.

In Australia past failures and losses have been due to a variety of causes ; amongst them may be enumerated a non-appreciation of the absence of natural water-storage, an ignorance of the adaptability of local soils and climate, unsuitable methods of working, a want of knowledge of the existence of an unlimited supply of artesian and sub-artesian waters, inadequate means of transit—both internal and external—and an uncertain market for products.

The staple product upon which Australia has developed is undoubtedly wool, and this item of commerce is still its chief export. We have not to go back many years to the time when the grower of wool was much in the dark as to the value of his crop.

The mutton was of very little value to the producer, the demand for such being entirely confined to our own small population. The wool was sent to the home markets entirely at the grower's risk, and the price he obtained for it there was quite problematical. The conditions being such, there was little incentive to make extensive monetary outlays for the conservation of water and fodder for the preservation of an asset of varying and uncertain value. Consequently when our seasonal dry periods came round (which are undoubtedly periods of soil rest), disaster was inevitable to a more or less extent.

Australia's commercial enterprise is on a very different basis now. With the perfection of refrigerating appliances, the meat markets of the world are open to it. The wool buyers of the world in competition give the highest current prices and relieve the grower of all responsibilities of transport to foreign markets. The squatter knows within narrow limits the value of his crop before it leaves the sheep's back. He therefore makes provision for preserving his stock, and conducts his enterprise on a business footing, in contrast with what was regarded in times gone by as a more or less speculative venture.

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The extension of railways enables the squatter to move his stock from seasonal dry areas to synchronous wet ones. The sinking of artesian and sub-artesian bores and the storage reservoirs, both national and private, have rendered vast areas immune from the more serious effects of droughts in what, formerly, was precarious territory.

Finally it may be said that the demand for Australia's wool has become such a factor in the world's supply that if the clip is short the growers as a body reap compensation in the enhanced monetary value obtained.

This fact was exemplified during the 1911–1912 clip, when a great falling off in quantity took place, as a result of the severest drought known in our climatological history over the greater part of Australian wool-producing areas, yet the value of the wool nearly aggregated that of the previous season, which had been a fairly good one.

The vicissitudes of wheat growing tell much the same tale. The sowing of drought-resisting grain, dry farming methods, and scientific manuring have, however, brought the proposition of profitable wheat growing from the problematical to the actual stage.

The output has been steadily growing from year to year, and considering that nearly 500,000 square miles of the continent receive a sufficient average rainfall, *i.e.*, 10 inches and over during the wheat-growing period (April to October), the possibilities of future development in this direction are unlimited.

The climatic history and prosperity of the last ten years or so contradict emphatically the preconceived notion that Australia was the particular drought-stricken and precarious area of the earth's surface. The truth of the matter about Australia's rainfall is that—(1) it is generally ample for pastoral and agricultural industries over two-thirds of its area; (2) different regions have distinct seasonal dry and wet periods, which must be more fully recognised and industrial operations adapted accordingly; (3) it is subject in part, but never in the whole, to prolonged periods when the rainfall is short of the seasonal average. Australia is not peculiar in this respect. It follows, therefore, that as the so far undeveloped country becomes populated and put to profitable use, the general wealth of the community as a whole will steadily increase.

Striking illustrations supporting the above statement have been furnished by both Victoria and New South Wales since the beginning of this century. The losses due to shortage of rain in Gippsland during that period were largely mitigated by the returns from the newly-developed Mallee territory, and this wealth, be it said, was derived from a part of the State which was previously regarded as worthless.

South-eastern New South Wales, which in earlier times largely comprised the developed portion of the State, suffered its greatest falling off in aggregate rainfall during the same period, and, had it not been for agricultural and pastoral enterprise in the west and dairying developments on the north coast, would have experienced the effects of its record drought, instead of attaining as it did the zenith of its prosperity.

2. The Seasons.

The months of December, January, and February, constitute summer; March, April, and May, autumn; June, July, and August, winter; and September, October, and November, spring.

January is generally the hottest month and July the coldest, but February is the hottest month in the coastal areas of Victoria and throughout Tasmania; December the warmest month in Northern Queensland; November at Port Darwin; and January and December at Broome.

These anomalies in the northern parts of Australia are probably due to the cooling effects of the monsoon rains, which seasonally occur there during the late summer months.

3. Temperature.

Australia possesses the most pacific and equable climate of all the continents. This is due to its geographical position, the absence of physiographical extremes, and its insularity. Its most northern limit is 11 degrees from the equator, and its southern about 50 from the South Pole, distances sufficiently remote from both to temper the severity of heat and cold, to which is added the modifying effects of the intervening oceans.

Of its total area, 1,149,320 square miles are situated north of the tropic, and 1,825,261 square miles to the south of it. Thus it has a wide range of climate. In Queensland, the Northern Territory, and the northern portions of Western Australia, there is an unlimited opening for the growth of tropical products, such as rubber, cotton, sugar, etc. Suitable areas south of the tropic may be found for all temperate classes of vegetation, including fruit.

January and February are the two hottest months, the mean temperatures ranging from 80 to 85 degrees over all the northern and central regions, and to 65 degrees and 70 degrees over the southern areas. Owing, however, to the declining angle of the sun's rays and the advent of the seasonal monsoonal rains, these temperatures rapidly fall, until in July, the coldest month, a mean as high as 75 degrees is experienced only over a very narrow strip of the northern sea coast, that over the southern half being 55 degrees and under.

During the hot months of the year the climate on the coast, except in the south, is invariably enervating. Inland, however, life is generally enjoyable, although the thermometer may, in extreme cases, reach as high as 120 degrees in the shade, the dryness of the air and consequent rapid cooling of the skin by evaporation preventing serious discomfort when protected from the direct rays of the sun. Nocturnal radiation, too, as contrasted with that of coastal districts, is very active, so that the nights are invariably cool, and an absence of monotony of temperature tends to a bracing of the system and to good sleep at night.

During some seasons parts of the continent are subject to prolonged heat spells, as for example, at Marble Bar, a mining township in the north-west of Western Australia, where the maximum thermometer reached 100 degrees Fah and over for 64 consecutive days in the year 1902. Nullagine, in the same region, recorded 100 degrees Fah. for 57 days in the year 1900; Boulia, in Western Queensland, 53 in 1902; Charlotte Waters, in the neighbourhood of Lake Eyre, 25 days in 1893; and Charleville, in Central Queensland, 20 days in 1893. Heat of this description is, however, confined to the interior. The figures of the State capitals will serve for confirmation of this point. Perth has only experienced a maximum temperature of 90 degrees and over on 20 consecutive days; Adelaide, 14; Melbourne and Brisbane, 8; Sydney, 4; and Hobart, 3; and it may fairly be assumed that extremes of climate in this respect have practically been reached, as records have been kept

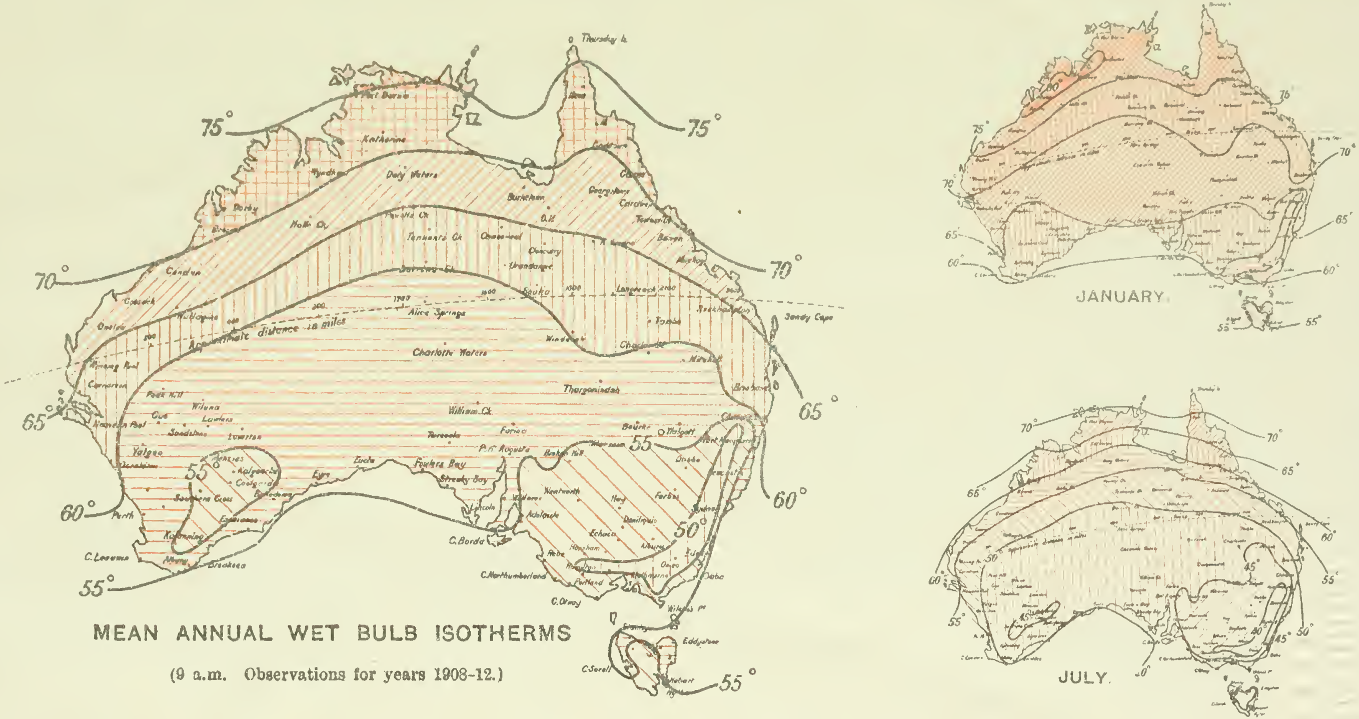
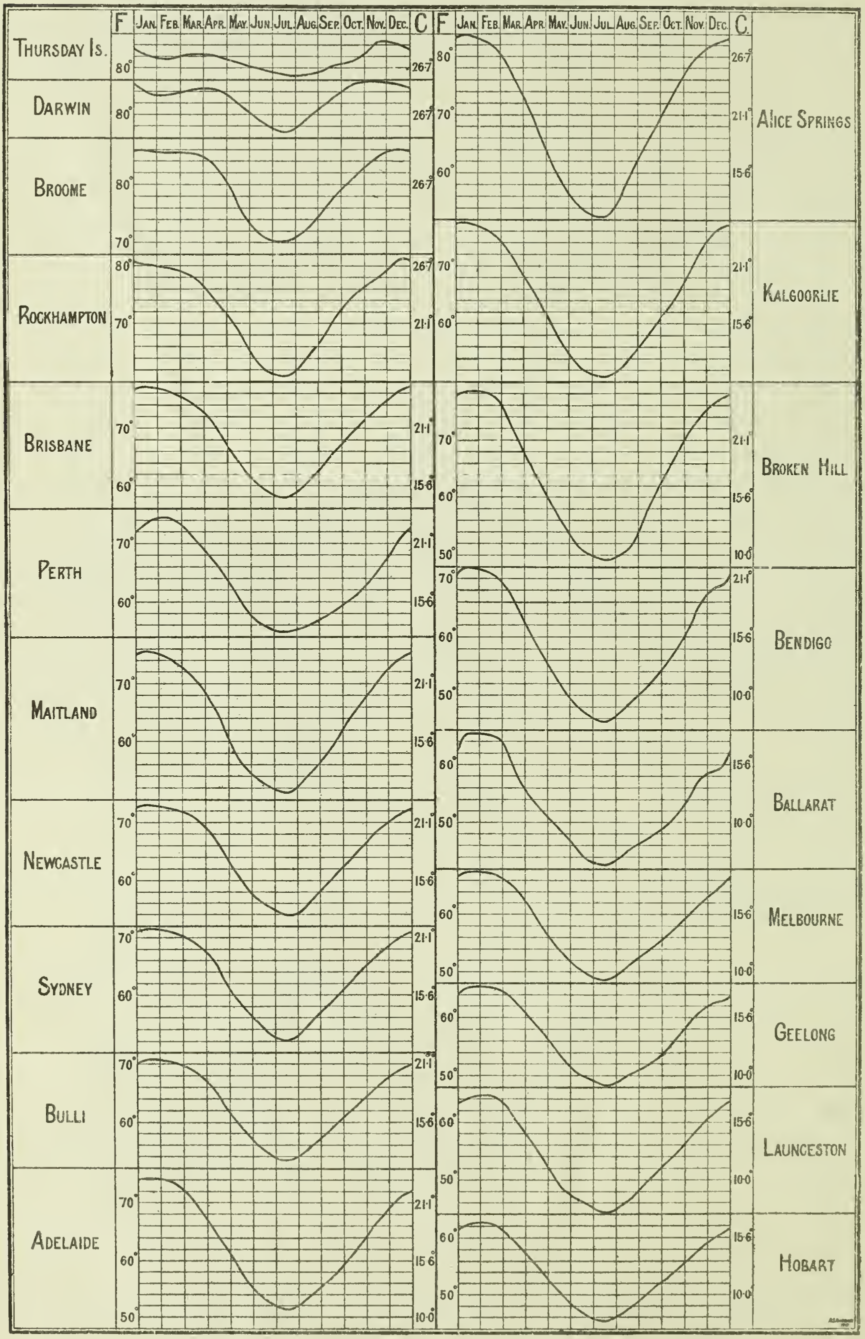


FIG. 1.—Wet Bulb Isotherms.

Graph showing Mean Monthly Temperatures of Principal Cities in Australia.



NOTE.—Each vertical space represents 2° Fahrenheit or 1·1° Centigrade.

FIG. 2.

at all the Observatories at these places, with the exception of Perth, for over half-a-century, a period sufficiently long for the establishment of temperature normals.

The foregoing remarks indicate that shade temperatures alone give only actual temperature as experienced by dry inorganic substances and not the sensible temperature as felt by organic bodies. This difference is due, as already stated, to cooling by the evaporation of moisture from the skin by wind and heat, but more especially by the action of wind. In order, therefore, to gauge the appreciable temperature of a country, it is necessary to use other instruments than the ordinary maximum and minimum thermometers. The principal additional instrument requisitioned for the desired end is the wet bulb thermometer.

A number of these have been distributed throughout Australia for the purpose of showing the disposition and trend of the wet bulb isotherms. Although the period over which observations have extended is not long enough to determine definite normals, yet sufficient records have been obtained to fairly establish the influence of this climatic element. At the outset it may be said that in no part of Australia is the wet bulb temperature maintained at a reading sufficiently high to be detrimental to the health and physique of those engaged in outdoor labour.

Investigations so far carried out confine the 80-degree Fah. wet bulb isotherm to a very narrow track of country on the north-west coast of Western Australia during the months of December, January, and February.

The 70-degree Fah. isotherm only extends to sub-tropical latitudes over comparative small areas in Queensland and Western Australia during the same months and March, while in southern Australia the readings are from 50 degrees to 70 degrees.

The accompanying table and graph show the average monthly and annual temperatures at a number of representative centres of the Commonwealth.

Broome, Port Darwin, and Thursday Island are the hottest of these, and have an annual average range of 16·6 degrees, 8·3 degrees, and 5·5 degrees respectively. The last-named is undoubtedly the most monotonously warm place of the continent.

Of the capital cities Brisbane is the hottest and Hobart the coldest, the others taking order between them as follows :—Perth, Sydney, Adelaide, and Melbourne. The annual average range between the hottest and coldest months is about 20 degrees in all these places.

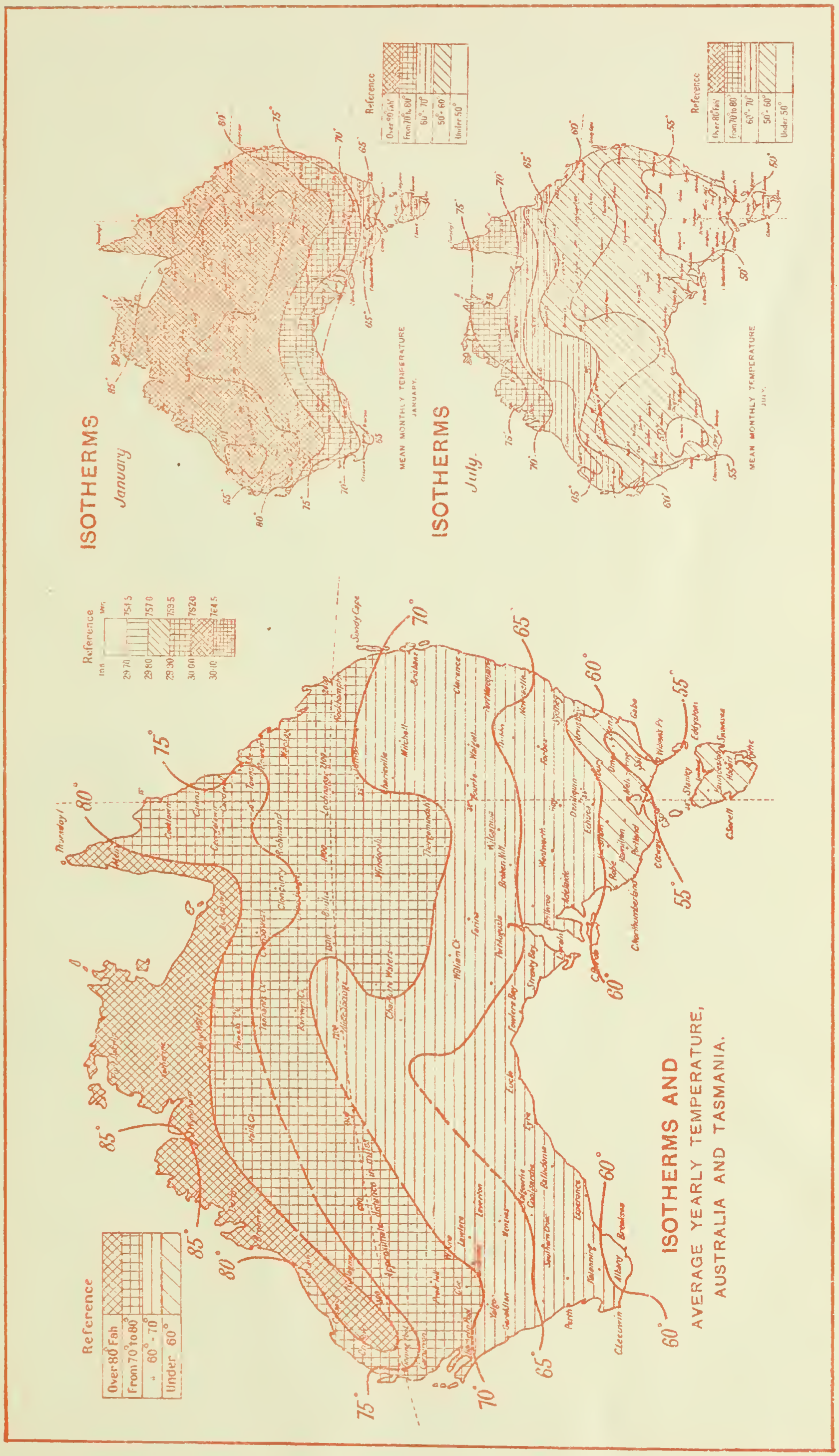
Taking Kalgoorlie and Broken Hill to represent conditions in the interior, we naturally find the extremes are much greater—Broken Hill's maximum of 78·4 degrees in January falls to a minimum of 49·2 degrees in July, a range of 29·2 degrees ; and Kalgoorlie's 77·5 degrees in January to 50·8 degrees in July, a range of 26·7 degrees.

In sub-tropical areas insolation is more active over the eastern half than over the western during the early summer months, and more active over parts of the western coastal districts during the late summer months.

In eastern Australia, too, the temperatures in the sub-tropics are about 1 degree higher than in corresponding latitudes in the west. North of the tropic these conditions are reversed, and between latitudes 17 degrees to 20 degrees the difference in excess is as much as 10 degrees in favour of the west coast.

TABLE OF MEAN MONTHLY AND ANNUAL TEMPERATURES AT CAPITALS AND PRINCIPAL TOWNS IN THE COMMONWEALTH.

City.	Latitude.	Longitude.	Height.	Distance from Coast.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	S.	E.	Feet.	Miles.	°	°	°	°	°	°	°	°	°	°	°	°	°
Port Darwin	12° 28′	130° 51′	97	..	84·0	83·4	84·2	84·4	81·9	79·0	77·1	79·3	82·7	85·5	85·8	85·4	82·7
Broome	17° 57′	122° 15′	34	..	85·9	85·4	85·4	83·1	76·4	71·2	71·3	72·4	77·0	81·0	84·6	85·9	79·9
Perth	31° 57′	115° 51′	197	12	73·6	74·2	71·2	66·4	60·4	56·2	55·0	56·0	57·9	60·9	65·4	70·6	64·0
Kalgoorlie (Coolgardie) ..	30° 45′	121° 30′	1,261	387	77·5	76·0	71·6	65·4	57·6	52·3	50·8	53·4	58·4	63·6	70·9	76·2	64·5
Alice Springs	23° 38′	133° 37′	1,926	576	84·0	82·3	76·7	68·1	59·7	54·3	52·5	58·3	65·6	73·5	79·5	82·4	69·7
Adelaide	34° 56′	138° 35′	140	6	74·2	73·9	69·9	64·0	57·7	53·4	51·5	53·8	57·0	61·9	67·1	71·1	62·9
Broken Hill	30° 58′	141° 21′	1,001	220	78·4	77·9	71·8	63·9	56·6	51·0	49·2	52·8	58·4	65·8	73·0	76·6	64·6
Bendigo	36° 46′	144° 17′	825	73	71·9	70·9	66·5	59·0	52·2	47·6	45·5	48·5	51·8	57·3	64·3	68·5	58·7
Ballarat	37° 33′	143° 52′	1,430	46	65·3	65·2	59·4	53·2	49·0	44·4	42·6	45·3	47·5	50·7	56·9	59·0	53·2
Geelong	38° 10′	144° 21′	90	1	65·3	65·4	62·7	58·7	53·7	50·2	48·3	50·1	51·9	55·9	60·5	62·7	57·1
Melbourne	37° 50′	144° 59′	115	3	67·5	67·3	64·6	59·5	54·1	50·3	48·4	51·0	54·0	57·5	61·3	64·6	58·3
Hobart	42° 53′	147° 22′	160	1	62·4	62·4	59·5	55·1	50·4	46·8	45·3	47·7	50·8	53·9	57·5	60·3	54·3
Launceston	41° 27′	147° 10′	33	32	64·1	64·5	60·6	55·5	49·1	46·5	44·1	46·3	50·2	53·9	58·2	62·0	54·6
Canberra	35° 20′	149° 15′	1,910	60	67·6	68·0	63·8	55·3	49·6	44·0	44·0	46·2	49·8	52·8	61·4	64·0	55·5
Bulli (Wollongong) ..	34° 25′	150° 56′	33	..	70·8	70·4	68·6	64·4	59·2	55·1	53·6	55·8	59·4	63·0	66·2	69·0	63·0
Sydney	33° 52′	151° 12′	146	5	71·6	71·0	69·2	64·5	58·6	54·3	52·3	54·8	58·8	63·4	67·0	70·0	63·0
Newcastle	32° 55′	151° 49′	112	1	73·0	72·4	71·0	66·4	60·3	56·0	54·0	56·2	60·4	64·9	68·6	71·5	64·6
Maitland	32° 45′	151° 35′	19	18	75·6	74·2	71·0	64·7	56·8	53·1	51·3	54·2	59·1	65·3	70·4	74·2	64·2
Brisbane	27° 28′	153° 2′	137	10	77·1	76·4	74·3	70·2	64·4	59·9	58·0	60·6	65·2	69·8	73·3	76·5	68·8
Rockhampton	23° 24′	150° 30′	37	18	80·2	79·6	78·3	74·0	69·0	62·6	61·0	64·2	69·7	74·9	77·8	81·2	72·7
Thursday Island	10° 34′	142° 12′	17	..	82·2	81·5	82·3	82·2	81·1	79·8	79·0	78·8	80·2	81·2	84·4	84·1	81·3



ISOTHERMS AND
AVERAGE YEARLY TEMPERATURE,
AUSTRALIA AND TASMANIA.

FIG 3

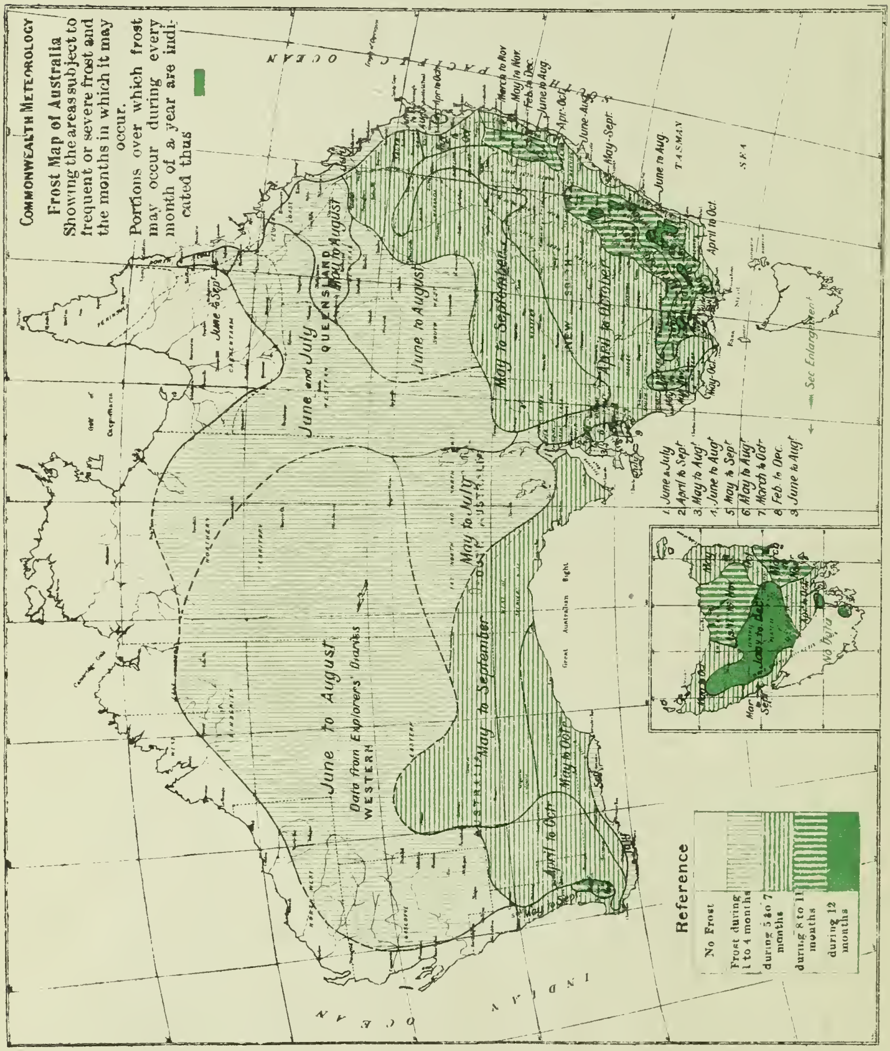


FIG. 4.—Frost Map.

4. Frosts.

Although observations have been taken continuously for a great number of years, no notes of appreciable frosts have been recorded over all the northern coastal regions extending from Geraldton on the west coast right round the north and east coasts to Brisbane. The same remark applies to Northern Territory.

In all other parts of Australia, however, night frosts are severe and frequent, although of considerably varying periods.

On the highlands in New South Wales, Victoria, and Tasmania, frosts of a more or less damaging nature have occurred in every month of the year. Over a stretch of country largely comprising the wheat areas of South Australia, Victoria, New South Wales, and Queensland, they have been recorded between April and October.

Over north-central and north-east Victoria, the south and central western slopes of New South Wales, from April to November; over the Gascoyne and north-eastern parts of Western Australia and Central Australia from June to August.*

In central and western Queensland from June to July, June to August, or May to August.

Over the southern portion of Western Australia from April to October, or May to September.

For details of frost periods and distribution, see Fig. 4.

5. Rainfall.

Sources of Rainfall.

The two main sources of Australian rainfall are the southern depressions which skirt the southern shores of the continent mainly during the winter months, and the tropical low pressure which operates chiefly in the summer months.

A secondary but important source of supply is the anticyclone, which by inducing a flow of moist air from the adjacent ocean waters at any time during the year may bring about copious rains over the eastern littoral.

The minor sources of rain are those of cyclones and tornadoes, but although these storms are characteristic of the country and result in heavy downpours, they cannot be regarded as staple or widespread givers of rain.

Physical Causes of Rain.

The condensation of water vapour into visible cloud form in the atmosphere is brought about generally by cooling. There are several known processes by which condensation results, and there may be other physical causes which give rise to the same effect, notably atmospheric electricity, but which are not at present properly understood.

These may be enumerated as follows:—

(1) The meeting of cold and warm currents of air forming condensation known as fog.

(2) Condensation by ascending currents due to convection.

(3) Condensation by forced ascending current, *i.e.*, air forced from the sea to the rising sea shore and up the sides of hills and mountains.

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* These data were largely gathered from explorers' diaries.

(4) Condensation by falling barometric pressure.
(5) Condensation by atmospheric wave
(6) Condensation by radiation.
(7) Condensation due to conduction.
(8) Condensation by diffusion of water vapour.

These processes have only to be continued sufficiently long for precipitation to take place either in the form of rain, snow, or hail.

The above definitions may be found in most meteorological text-books, and are only repeated here to emphasize the fact that one of the most important processes, at all events as far as it applies to Australian Meteorology, has hitherto been generally overlooked, and that is the movement of air from warm to cool latitudes and zones causing condensation and finally bounteous precipitation over vast areas, with more or less disregard to the influence of land elevation or of barometric fluctuations.

During the present year, 1913, many examples of this phenomenon have occurred, and the break up of the dry spell over eastern Australia in June, 1912, was a conspicuous one.

The characteristic isobaric conditions which precede or accompany this form of rain production are anticyclones of great dimensions and of considerable intensity, covering the eastern half of Australia, and perhaps an equal area of the ocean to the east. Their western isobars are comparatively straight, extending from the Indian Ocean east from the meridian of Port Darwin to the Southern Ocean east of Spencer's Gulf. The following and attending areas of the low pressure generally take the form of a shallow trough or valley in the atmosphere extending through the centre of Australia from the northern to the southern seaboards. It will thus be seen that a direct and rapid wind circulation control extends from the equatorial zone to temperate latitudes resulting in conditions particularly favorable for widespread and heavy downpours.

The rainy season in Western Australia may be said to result almost solely from this physical action.

The rain-bearing winds are northerly, precipitation becoming heavier as higher latitudes are reached.

Over Papua the reverse action takes place; during the dry season the winds are strong and persistent from the south-east quarter, blowing from cool to warmer latitudes. The water vapour carried by these winds is therefore expanded instead of precipitated.

On the occasion of the rain storm of June, 1912, it is estimated from this cause of precipitation that an inch of rain on the average fell over an area approximating 1,000,000 square miles of eastern Australia, or a weight of water roughly equivalent to 1,000,000 × 640 × 100 = 64,000,000,000 tons.

The knowledge that rain visitations of this character are not infrequent completely dispels the preconceived notion of Australia being a particularly dry area of the earth's surface, and shews that although our rain seasons may be irregular, yet relief from dry spells may occur, as in the case quoted, at times long after the normal period for rain has passed. This peculiarity is a great advantage and a happy feature of Australian climate; and very different from conditions, say, for example, that obtain in India—where, if the monsoon season fails to bring rain, very little hope of relief can be looked for.

Before finally leaving this point, it may definitely be accepted that any isobaric distribution that controls a strong wind circulation from warm to cool areas, more especially from warm to cool latitudes, will bring about good rains, and, moreover, that the recurrence of such isobaric distributions are typical events of good seasons. (See Fig. 5.)

On the other hand, extensive isobaric distributions that control a wind circulation from cool to warm zones or latitudes, or that control a wind circulation along parallels of latitude, will bring little or no rain except in opposing coastal areas. These distributions predominate during and are typical of a dry season. (See Fig. 6.)

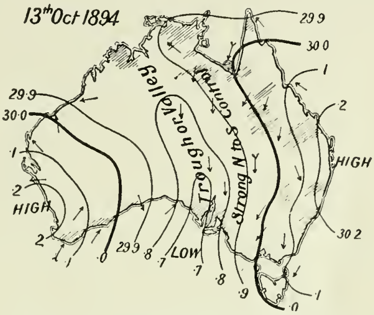


Fig. 5.—Isobaric Distribution (wet type).

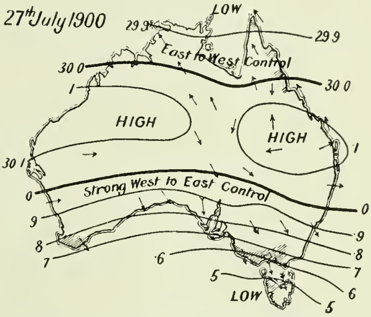


Fig. 6.—Isobaric Distribution (dry type).

6. The Normal Monthly Distribution of Rain.

A set of charts illustrating the monthly progress of rainfall in Australia has recently been published. Those of January and July, together with one for the whole year, are here reproduced. They were compiled from data extending over a considerable period, generally from 20 to 40 years (there being only a few stations with a minimum of fifteen years' record), so that the isohyets are likely to suffer little modification in the future.

A casual glance at the series reveals three marked facts—(1) that during the hotter months, viz., November to April inclusive, the northern parts of Australia are wet and the southern dry; (2) that during the colder months viz., May to October inclusive, the southern parts are wet, and the northern dry; (3) that the rainfall is distributed fairly generally throughout the year over the eastern areas of Australia.

During January and February fully three-fourths of the continent, comprising the whole of the northern and eastern areas, are wet, while the central, southern, and south-western portions are distinctly dry. In March, there is a general retreat northward of the rainfall area to the extent of 200 miles in Western Australia, a slight extension westward in the south-east quarter of the continent, and in Western Australia the 1-in. isohyetal appears on the extreme south-west coast.

In April the northern rain area retreats in central Australia from the tropic to within 300 miles of the north coast, although still lagging over the north-west coast of Western Australia and the Murchison gold-fields.

In the south a decided westerly extension takes place from the south-eastern States to South Australia and Western Australia, the 1-in. isohyetal sweeping continuously around the southern shores with the exception of a short break at the head of the Great Bight.

The northern rain entirely disappears in May, and the southern extends up the west coast of Western Australia to within a few miles of Cossack, and the quantities increase as compared with those of the previous month by 4 inches in the extreme south-west corner.

June, the wettest month of the year for southern Australia, shows a complete reversal of January rain conditions. In Western Australia precipitation is general during this month west of a line joining Derby and Eyre, and in South Australia the 1-in. isohyet reaches its furthest northern limit in close proximity to Farina.

From July to December it may be remarked that the rain area as a whole swings back in the opposite direction to its march during the first six months.

On the west coast the 1-in. line steps back to Onslow in July; to Hamelin Pool in August; to Geraldton in September; still farther south in October; and all but disappears in the extreme south-west in November; so that little or nothing is left in December. While this retreating process is taking place in the west, a corresponding advance movement is going on in the east. Between the end of June and the end of August there is little change, but from September to the end of the year the expansion of area and quantity of rain increases rapidly. October shows the return of the monsoon rain in Northern Territory. In November it has penetrated 450 miles further into the interior and connected up with the permanent rain area over eastern Australia.

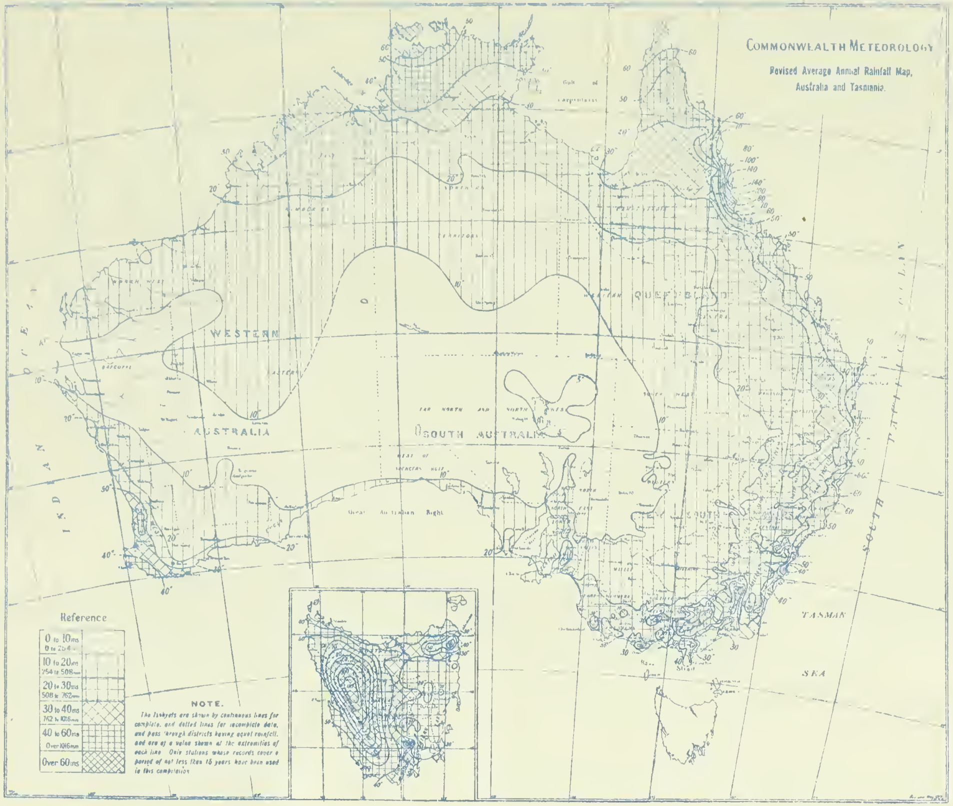
In December, the monsoon rain covers practically the whole of the continent north of the Tropic, and east of the 144th meridian.

We find, therefore, that there exists apparently an oscillatory movement of the seasonal rains of Australia about a centre in the vicinity of Forbes, in New South Wales. It is perhaps a natural coincidence that this apparent centre of oscillation is approximately the centre of gravity of Australia's population, and is not far from the Federal capital site; another interesting point is that the amplitude of oscillation exactly equals 72 degrees of arc or one-fifth of a circle.

7. Wettest Months.

Roughly speaking, June is the wettest month over that portion of Australia lying to the south of a line joining Onslow on the north-west coast of Western Australia and Sydney on the east coast.

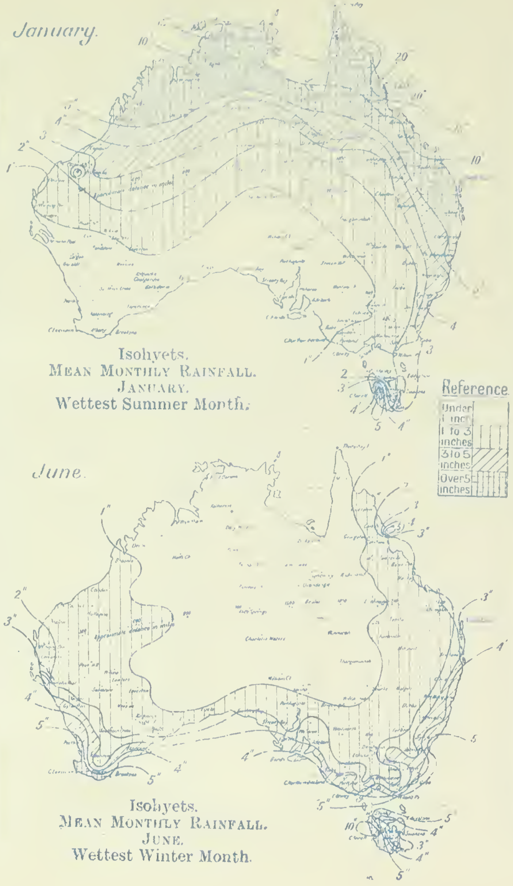
To the north of that line, January commands the greatest claim as the wettest month, although February runs it very closely over a wide belt of country extending from the lower Northern Territory through south-west Queensland to northern parts of New South Wales. March also is the



NOTE.

The Isohyets are shown by continuous lines for complete, and dotted lines for incomplete data, and pass through districts having equal rainfall, and are of a value shown at the extremities of each line. Only stations whose records cover a period of not less than 15 years have been used in this compilation.

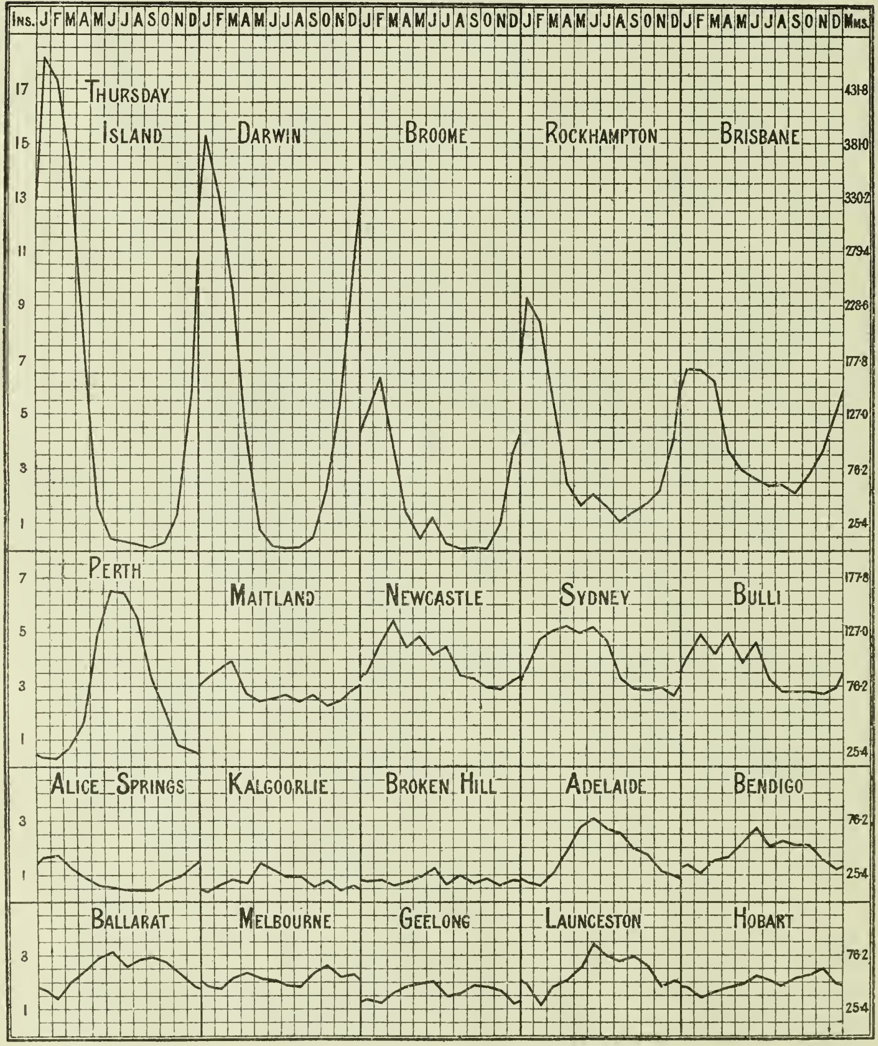
FIG. 7.—Rainfall Map.



Isohyets.
MEAN MONTHLY RAINFALL.
JANUARY.
Wettest Summer Month.

Isohyets.
MEAN MONTHLY RAINFALL.
JUNE.
Wettest Winter Month.

Graph showing Mean Monthly Rainfall of Principal Cities in Australia.



NOTE.—Each vertical space represents ·5 of an inch or 12·7 millimetres.

FIG. 8.

wettest month in parts of central Queensland, parts of central New South Wales, and over a comparatively small area on the north-west coast of Western Australia.

As would naturally be expected, at the junction of the summer and winter rains, which is represented by the line above mentioned crossing the continent from north-west to south-east, the wettest month is somewhat indeterminate. This point is particularly noticeable in the State of New South Wales, through which the line centrally passes, for within its boundaries every month with the exception of September is represented as the wettest month in some part or other, with a preponderance, as before stated, for June in the southern half, and January, February, and March in the northern half, as the months of heaviest total falls.

HEAVY RAINFALLS, WESTERN AUSTRALIA.

Name of Town or Locality.	Date.	Amount.	Name of Town or Locality.	Date.	Amount.
		inches.			inches.
Ascott	8 Feb., 1912	8·85	La Grange	21 Dec., 1905	7·61
,,	9 Feb., 1912	5·85	Millstream	5 Mar., 1900	10·00
Balla Balla	20 Mar., 1899	6·00	Obagama	16 Feb., 1896	3·95
,,	21 Mar., 1899	14·40	,,	17 Feb., 1896	6·30
Bamboo Creek	22 Mar., 1899	10·10	,,	18 Feb., 1896	7·22
Boodarie	3 Jan., 1894	10·03	,,	28 Feb., 1910	12·00
,,	4 Jan., 1894	5·22	Point Cloates	20 Jan., 1909	10·87
,,	21 Mar., 1899	14·53	Point Torment	17 Dec., 1906	11·86
,,	6 Feb., 1901	1·91	Port Hedland	7 Feb., 1901	3·56
,,	7 Feb., 1901	9·16	,,	8 Feb., 1901	9·55
Carlton	11 Jan., 1903	10·64	Quanbun	29 Apr., 1910	6·55
,,	8 Feb., 1912	9·05	,,	30 Apr., 1910	3·40
,,	9 Feb., 1912	3·15	Roebourne	3 Apr., 1898	11·44
Cherrabun	28 Apr., 1910	2·90	,,	6 Mar., 1900	10·32
,,	29 Apr., 1910	7·78	Tambrey	,, ,,	11·00
Cocos Island	29 Nov., 1903	14·38	,,	3 Mar., 1903	10·47
,,	26 Dec., 1907	8·00	Thangoo	17–19 Feb., 1896	24·18
,,	27 Dec., 1907	2·65			
,,	8 July, 1908	10·21	,,	28 Dec., 1898	11·15
,,	9 July, 1908	2·75	,,	20 Nov., 1910	7·40
,,	23 July, 1908	2·40	,,	21 Nov., 1910	4·56
,,	24 July, 1908	7·00	Whim Creek	2 Apr, 1898	7·08
,,	25 July, 1908	3·85	,,	3 Apr., 1898	29·41
,,	6 Oct., 1910	12·70	,,	20 Mar., 1899	8·89
Cossack	3 Apr., 1898	12·82	,,	21 Mar., 1899	18·17
,,	15 Apr., 1900	6·89	,,	6 Mar., 1900	10·32
,,	16 Apr., 1900	13·23	,,	3 Mar., 1903	10·44
Croydon	3 Mar., 1903	12·00	Woodstock	21 Mar., 1913	13·00
De Grey	3 Jan., 1894	9·75	Wyndham	27 Jan., 1890	11·60
Derby	29 Dec., 1898	13·09	,,	11 Jan., 1903	9·98
,,	30 Dec., 1898	7·14	,,	12 Jan., 1903	6·64
Fortescue	3 May, 1890	23·36	,,	13 Jan., 1903	4·20
Indee	22 Mar., 1890	5·08	Yeeda	28 Dec., 1898	8·42
,,	23 Mar., 1890	5·40	,,	29 Dec., 1898	6·88
Kerdiadary	7 Feb., 1901	12·00	,,	30 Dec., 1898	6·12
La Grange	20 Dec., 1905	3·70			

HEAVY RAINFALLS, SOUTH AUSTRALIA.

Name of Town or Locality.	Date.	Amount.	Name of Town or Locality.	Date.	Amount.
		inches.			inches.
Arltunga	1 Mar., 1910	1·02	Port Darwin	7 Jan., 1897	11·67
"	2 Mar., 1910	1·42	"	26 Dec., 1911	1·42
"	3 Mar., 1910	7·77	"	27 Dec., 1911	7·87
"	4 Mar., 1910	1·85	"	28 Dec., 1911	2·06
"	5 Mar., 1910	1·24	Powell's Creek	25 Feb., 1910	2·31
Borroloola	14 Mar., 1899	14·00	"	26 Feb., 1910	1·21
Lake Nash	21 Mar., 1901	10·25	"	27 Feb., 1910	8·19
Pine Creek	8 Jan., 1897	10·35	Tennant's Creek	26 Feb., 1910	1·18
Point Charles	30 Jan., 1913	4·46	"	27 Feb., 1910	1·02
"	31 Jan., 1913	5·60	"	28 Feb., 1910	9·22

HEAVY RAINFALLS, QUEENSLAND.

Name of Town or Locality.	Date.	Amount.	Name of Town or Locality.	Date.	Amount.
		inches.			inches.
Anglesey	26 Dec., 1909	18·20	Cairns	5 Apr., 1891	14·08
Ascot	14 Mar., 1908	11·34	"	9 Jan., 1892	10·56
Ayr	20 Sept., 1890	14·58	"	4 Jan., 1909	11·56
"	25 Mar., 1891	10·19	"	3 Jan., 1911	11·97
"	26 Jan., 1896	10·50	"	11 Feb., 1911	15·17
Babinda	17 Mar., 1912	10·15	"	17 Mar., 1911	10·35
Beenleigh	21 Jan., 1887	11·30	"	1 Apr., 1911	11·71
"	14 Mar., 1908	10·40	"	2 Apr., 1911	20·16
Bloomsbury	14 Feb., 1893	17·40	Caloundra	21 Jan., 1887	10·50
"	27 Jan., 1896	10·52	Cape Capricorn	17 Jan., 1905	10·16
"	10 Jan., 1901	16·62	Cape Grafton	5 Mar., 1896	13·37
"	4 Mar., 1906	11·36	Cardwell	18 Mar., 1887	10·15
"	9 Jan., 1908	11·30	"	30 Dec., 1889	12·00
Boggo-road Junction	14 Mar., 1908	10·42	"	2 Jan., 1890	10·06
			"	23 Mar., 1890	12·00
Botanic Gardens, Brisbane	" "	10·80	"	18 Mar., 1904	18·24
			"	3 Apr., 1911	12·84
Bowen	13 Feb., 1893	14·65	"	7 Apr., 1912	11·90
"	20 Jan., 1894	11·11	Cedar Pocket	26 Dec., 1909	11·36
Bowen Park	16 Feb., 1893	10·38	Central Kin Kin	" "	10·17
"	14 Mar., 1908	11·50	Chiefswood	14 Mar., 1898	11·01
Brisbane	21 Jan., 1887	18·31	Childers	6 Mar., 1898	11·28
"	14 Mar., 1908	11·18	Clare	26 Jan., 1896	15·30
Bromby Park (Bowen)	14 Feb., 1893	13·28	Cleveland	13 Jan., 1910	10·13
			"	2 June, 1910	11·20
" "	20 Jan., 1894	11·20	Coen	20 Apr., 1903	11·11
Brookfield	14 Mar., 1908	14·95	"	1 Apr., 1910	10·71
Buderim Mountain	11 Jan., 1898	26·20	Collaroy	30 Jan., 1896	14·25
" "	9 Mar., 1898	11·10	"	30 Jan., 1910	10·25
Bulimba (Brisbane)	16 Feb., 1893	10·40	Cooktown	22 Jan., 1903	12·49
Bundaberg	31 Jan., 1893	10·15	"	19 Jan., 1907	11·70
Burketown	15 Jan., 1891	13·58	"	1 Apr., 1911	11·11
"	12 Mar., 1903	14·52	Cooran	1 Feb., 1893	13·62
Bustard Head	18 Feb., 1888	10·14	"	9 June, 1893	10·12
"	30 Jan., 1893	11·85	"	26 Dec., 1908	14·08
Caboolture	21 Jan., 1887	10·00	Cooroy	9 June, 1893	13·60
"	10 Jan., 1898	10·28	"	10 Jan., 1898	13·50
Cairns	11 Feb., 1889	14·74	"	6 Mar., 1898	10·04
"	21 Apr., 1889	12·40	Cressbrook	16 Feb., 1893	10·65

HEAVY RAINFALLS, QUEENSLAND—*continued.*

Name of Town or Locality.	Date.	Amount.
		inches.
Crohamhurst (Blackall Range)	31 Jan., 1893	10·78
,, ,,	2 Feb., 1893..	35·71
,, ,,	9 June, 1893	13·31
,, ,,	9 Jan., 1898..	19·55
,, ,,	6 Mar., 1898	16·01
,, ,,	26 Dec., 1909	13·85
Crow's Nest ..	2 Aug., 1908	11·17
Croydon ..	29 Jan., 1908	15·00
Cryna (Beaudesert)	21 Jan., 1887	14·00
Dungeness ..	16 Mar., 1893	22·17
,, ..	19 Jan., 1894	11·84
,, ..	17 Apr., 1894	14·00
Dunira	9 Jan., 1898..	18·45
,, ..	6 Mar., 1898	15·95
Eddington (Cloncurry)	23 Jan., 1891	10·33
Emu Park ..	31 Jan., 1893	10·00
Enoggera Railway	14 Mar., 1908	12·14
Enoggera Reservoir	,, ,,	10·98
Ernest Junction ..	,, ,,	13·00
Esk	21 Jan., 1887	10·70
,, ...	14 Mar., 1908	11·12
Fassifern ..	21 Jan., 1887	10·20
Flat Top Island ..	22 Dec., 1909	12·96
Floraville ..	6 Jan., 1897..	10·79
,, ..	11 Mar., 1903	12–86
Flying Fish Point	7 Apr., 1912..	16·06
Geraldton (now Innisfail)	11 Feb., 1889	17·13
,, ,,	31 Dec., 1889	12·45
,, ,,	25 Jan., 1892	11·10
,, ,,	6 Apr., 1894..	16·02
,, ,,	3 Mar., 1896	11·42
,, ,,	7 Mar., 1899	10·25
,, ,,	18 Apr., 1899.	13·20
,, ,,	24 Jan., 1900	15·22
,, ,,	6 Jan., 1901..	11·35
,, ,,	29 Dec., 1903	21·22
,, ,,	17 Mar., 1904	10·35
,, ,,	30 Jan., 1908	11·76
,, ,,	14 Jan., 1909	11·65
,, ,,	11 Feb., 1911	14·48
,, ,,	1 Apr., 1911..	12·35
,, ,,	2 Apr., 1911..	15·00
,, ,,	3 Apr., 1911..	11·25
,, ,,	7 Apr., 1912..	20·50
,, ,,	8 Apr., 1912..	12·15
Gin Gin.. ..	16 Jan., 1905	13·61
Gladstone ..	18 Feb., 1888	12·37
,, ..	31 Jan., 1893	14·62
,,	4 Feb., 1911..	18·83
Glass Mountains ..	26 Dec., 1909	10·48
Glen Broughton ..	5 Apr., 1894..	18·50
Glen Prairie ..	18 Apr., 1904	12·18
Gold Creek Reservoir	16 Feb., 1893	11·16
,, ,,	14 Mar., 1908	12·50
Goodna ..	21 Jan., 1887	11·00
,, ..	14 Mar., 1908	11·03
Goondi Mill (near Innisfail)	25 Jan., 1892	11·10
,, ,,	6 Apr., 1894..	15·69
,, ,,	7 Mar., 1899	10·08
,, ,,	18 Apr., 1899	14·78
,, ,,	24 Jan., 1900	13·30
,, ,,	6 Jan., 1901..	10·70
,, ,,	2 Mar., 1901	10·67
,, ,,	29 Dec., 1903	17·83
,, ,,	17 Mar., 1904	10·00
,, ,,	21 Mar., 1910	10·38
,, ,,	10 Feb., 1911	17·68
,, ,,	31 Mar., 1911	12·38
,, ,,	1 Apr., 1911..	13·60
,, ,,	6 Apr., 1912..	15·55
Granada (late Donaldson)	27 Jan., 1891	11·29
,, ,,	8 Jan., 1911..	13·50
,, ,,	9 Jan., 1911..	14·30
Gympie ..	9 Mar., 1901	11·64
Halifax ..	5 Feb., 1899..	15·37
,, ...	8 Mar., 1899	11·00
,, ..	6 Jan., 1901..	15·68
,, ..	8 Feb., 1901..	10·50
,, ..	26 Mar., 1903	10·07
,, ..	30 Jan., 1906	10·41
,, ..	8 Apr., 1912..	12·75
Hambledon Mill ..	7 Jan., 1908..	11·00
,, ,, ..	13 Jan., 1909	13·80
,, ,, ..	16 Feb., 1910	11·45
,, ,, ..	2 Jan., 1911..	18·61
,, ,, ..	10 Feb., 1911	13·97
,, ,, ..	30 Mar., 1911	13·04
,, ,, ..	31 Mar., 1911	14·95
,, ,, ..	1 Apr., 1911..	19·62
Harvey Creek ..	8 Mar., 1899	17·72
,, ,, ..	25 Jan., 1900	12·53
,, ,, ..	25 May, 1901	14·00
,, ,, ..	14 Mar., 1903	12·10
,, ,, ..	21 Apr., 1903	10·10
,, ,, ..	11 Jan., 1905	16·96
,, ,, ..	28 Jan., 1906	12·29
,, ,, ..	20 Jan., 1907	10·13
,, ,, ..	8 Jan., 1908..	10·31
,, ,, ..	30 Jan., 1908	11·31
,, ,, ..	25 Mar., 1908	11·84
,, ,, ..	14 Jan., 1909	14·40
,, ,, ..	16 Feb., 1910	10·90
,, ,, ..	3 Jan., 1911..	27·75
,, ,, ..	11 Feb., 1911	12·88
,, ,, ..	31 Mar., 1911	10·93
,, ,, ..	1 Apr., 1911..	13·61
,, ,, ..	2 Apr., 1911..	16·46
,, ,, ..	17 Mar., 1912	10·15
Haughton Valley	26 Jan., 1896	18·10
Hillcrest (Mooloolah)	26 Dec., 1909	13·35
Holmwood (Woodford)	2 Feb., 1893..	16·19
,, ,,	10 Jan., 1898	12·40

HEAVY RAINFALLS, QUEENSLAND—*continued.*

Name of Town or Locality.	Date.	Amount. inches.
Homebush ..	3 Feb., 1898..	12·04
,, ..	21 Mar., 1898	10·26
,, ..	11 Jan., 1901	11·40
Howard ..	15 Jan., 1905	19·55
Indooroopilly ..	14 Mar., 1908	10·28
Ingham ..	18 Jan., 1894	12·60
,, ..	7 Apr., 1894..	10·10
,, ..	6 Jan., 1901..	13·59
,, ..	25 Dec., 1903	12·30
Inkerman ..	21 Sept., 1890	12·93
Inneshowen (Johntone River)	30 Dec., 1889	14·01
Innisfail ..	7 Apr. 1912..	20·50
,, ..	8 Apr. 1912 .	12·15
Inskip Point ..	13 Mar., 1892	10·65
Isis Junction ..	6 Mar., 1898	13·60
Kamerunga (Cairns)	20 Jan., 1892	13·61
,, ..	23 Feb., 1894	10·10
,, ..	6 Apr., 1894..	14·04
,, ..	5 Apr., 1895..	12·31
,, ..	5 Mar., 1896	11·81
,, ..	8 Mar., 1899	10·50
,, ..	21 Apr., 1903	11·75
,, ..	2 Jan., 1911..	10·95
,, ..	3 Jan., 1911..	10·25
,, ..	11 Feb., 1911	13·07
,, ..	17 Mar., 1911	10·30
,, ..	1 Apr., 1911..	14·20
,, ..	2 Apr., 1911..	21·00
Kilkivan Junction	10 Jan., 1898	11·08
Kululu, Mackay ..	11 Jan., 1901	11·70
,, ,, ..	12 Jan., 1905	10·94
Kuranda ..	6 Mar., 1899	14·12
,, ..	20 Apr., 1903	14·16
,, ..	14 Jan., 1909	12·37
,, ..	27 Jan., 1910	9·40
,, ..	28 Jan., 1910	9·28
,, ..	3 Jan., 1911..	10·72
,, ..	11 Feb., 1911	16·30
,, ..	17 Mar., 1911	15·10
,,	31 Mar., 1911	18·60
,, ..	1 Apr., 1911..	24·30
,, ..	2 Apr., 1911..	28·80
Lake Nash ..	10 Jan., 1895	10·25
,, ..	20 Mar., 1901	10·02
Landsborough ..	2 Feb., 1893..	15·15
,, ..	9 June, 1893	12·80
,, ..	9 Jan., 1898..	9·54
,,	7 Mar., 1898	10·35
,, ..	26 Dec., 1909	14·00
Low Island ..	10 Mar., 1904	15·07
,, ..	16 Mar., 1911	10·15
,, ..	31 Mar., 1911	14·70
,, ..	1 Apr., 1911..	15·30
Lucinda ..	4 Feb., 1899..	11·10
,, ..	17 Feb., 1906	13·35
,, ..	10 Mar., 1906	14·60
Lytton	21 Jan., 1887	12·85
.. ..	13 Mar. 1892	10·60
Lytton	16 Feb., 1893	11·74
,, ...	20 Mar., 1898	10·20
Mackay ..	17 Feb., 1888	10·10
,, ..	15 Feb., 1893	10·46
,, ..	3 Feb., 1898..	11·95
,, ..	5 Jan., 1904..	10·45
,, ..	23 Dec., 1909	13·96
,, ..	12 Mar., 1910	10·31
Sugar Experimental Farm, Mackay	23 Dec., 1909	12·00
Macnade Mill (Townsville)	28 Mar., 1891	10·61
,, ,,	15 Mar., 1893	10·50
,, ,,	18 Jan., 1894	12·56
,, ,,	17 Apr., 1894	14·26
,, ,,	5 Feb., 1899..	15·20
,, ,,	6 Jan., 1901..	23·33
Maleny	14 Mar., 1908	10·95
,, ...	26 Dec., 1909	14·76
Manly ..	14 Mar., 1908	11·90
Mapleton ..	14 Mar., 1908	14·29
,, ..	26 Dec., 1909	15·72
,, ..	4 Feb., 1911..	10·07
Mareeba ..	31 Mar., 1911	10·59
Marlborough ..	17 Feb., 1888	14·24
,, ..	29 Jan., 1896	10·84
Mayne Junction ..	14 Mar., 1908	10·30
Mein	4 Apr., 1895..	10·50
Milton ..	14 Mar., 1908	12·24
Mirani	12 Jan., 1901	16·59
,, ...	28 Mar., 1903	10·16
Molloy	16 Mar., 1911	11·50
,, ...	30 Mar., 1911	10·00
,, ...	31 Mar., 1911	20·00
,, ...	1 Apr., 1911..	20·00
,, ...	2 Apr., 1911..	20·00
Monkira ..	1 Feb., 1906..	11·61
Mooloolah ..	13 Mar., 1892	21·53
,, ..	2 Feb., 1893..	19·11
,, ..	9 June, 1893	11·50
,, ..	6 Mar., 1898	14·43
Morningside ..	14 Mar., 1908	10·50
Mount Crosby ..	14 Mar. 1908	14·00
Mount Cuthbert ..	18 Jan., 1911	18·00
Mount Gravatt ..	14 Mar., 1908	10·80
Mount Perry ..	24 Feb., 1887	10·00
Mourilyan ..	14 Jan., 1909	13·00
,, ..	3 Jan., 1911..	12·70
,, ..	11 Feb., 1911	17·40
,, ..	1 Apr., 1911	13·20
,, ..	2 Mar., 1911..	10·59
,, ..	7 Apr., 1912..	18·97
Mundoolun ..	21 Jan., 1887	17·95
Mungar Junction	10 Mar., 1901	10·20
Murrarie ..	14 Mar., 1908	11·50
Musgrave ..	6 Apr., 1894..	13·71
Nambour ..	9 Jan., 1898..	21·00
,, ..	7 Mar., 1898	13·28
,, ..	27 Dec., 1909	16·80

HEAVY RAINFALLS, QUEENSLAND—*continued.*

Name of Town or Locality.	Date.	Amount.	Name of Town or Locality.	Date.	Amount.
		inches.			inches.
Nanango	9 June, 1893	10·00	Tabragalba	21 Jan., 1887	10·00
Nerango	15 June, 1892	12·35	Tallebudgera	14 Mar., 1908	10·80
,,	14 Mar., 1908	10·95	Tambourine Mountain	17 July, 1889	10·91
Netley (Rockhampton)	29 Jan., 1896	11·77			
			Taringa	14 Mar., 1908	11·40
Normanton	14 Jan., 1905	10·72	Tewantin	10 Jan., 1898	10·51
North Pine	11 Jan., 1887	11·60	,,	30 Mar., 1904	12·30
,,	16 Feb., 1893	14·97	,,	14 Apr., 1904	11·36
Nundah	14 Mar., 1908	12·00	The Hollow (Mackay)	23 Feb., 1888	15·12
One Mile, Gympie	10 Mar., 1901	11·40			
Oxenford	14 Mar., 1908	15·65	,, ,,	— Mar., 1891	10·39
Palmwoods	4 Feb., 1893	12·30	Thornborough	20 Apr., 1903	18·07
,,	10 Jan., 1898	15·85	Tierawoomba	2 Feb., 1898	10·36
,,	7 Mar., 1898	13·02	Tooloombah	29 Jan., 1896	11·70
,,	25 Dec., 1909	17·75	Toowong	14 Mar., 1908	11·60
,,	3 Mar., 1912	10·00	Townsville	24 Jan., 1892	19·20
Peachester	26 Dec., 1909	14·91	,,	28 Dec., 1903	15·00
Pinkenba	14 Mar., 1908	11·63	Victoria Mill	6 Jan., 1901	16·67
Pittsworth	11 Mar., 1890	14·68	Walkerston	12 Jan., 1905	10·60
Port Douglas	15 Mar., 1887	13·00	Walsh River	12 Jan., 1903	10·22
,,	12 Feb., 1888	10·00	,,	1 Apr., 1911	13·70
,,	20 Jan., 1892	11·50	Woodford	2 Feb., 1893	14·93
,,	23 Feb., 1894	10·25	,,	10 Jan., 1898	11·40
,,	7 Apr., 1894	10·00	Woodlands (Yeppoon)	10 Jan., 1889	10·00
,,	10 Mar., 1904	16·34			
,,	29 Dec., 1904	10·67	,, ,,	26 Jan, 1890	10·22
,,	11 Jan., 1905	14·68	,, ,,	25 Mar., 1890	14·25
,,	2 Jan., 1911	11·64	,, ,,	31 Jan., 1893	23·07
,,	11 Feb., 1911	11·88	,, ,,	30 Jan., 1896	11·91
,,	7 Mar., 1911	16·10	,, ,,	9 Feb., 1896	13·97
,,	1 April, 1911	31·53	,, ,,	7 Jan., 1898	14·50
Ravenswood	24 Mar., 1890	17·00	Woodstock	4 Nov., 1903	10·44
,,	27 Jan., 1896	10·52	Woogaroo	14 Mar., 1908	11·20
Redcliffe	21 Jan., 1887	14·00	Woombye	26 Dec., 1909	13·42
,,	16 Feb., 1893	17·35	Wynnum	14 Mar., 1908	11·95
,,	10 Jan., 1898	10·25	Yandina	1 Feb., 1893	20·08
Riverview	14 Mar., 1908	10·12	,,	9 June, 1893	12·70
Rockhampton	17 Feb., 1888	10·82	,,	9 Jan., 1898	19·25
,,	29 Jan., 1896	10·53	,,	7 Mar., 1898	13·52
Rosedale	6 Mar., 1898	12·60	,,	28 Dec., 1909	15·80
Sandgate	21 Jan.. 1887	10·50	Yarrabah	14 Jan., 1909	11·20
,,	16 Feb., 1893	14·03	,,	3 Jan., 1911	11·50
Sherwood	14 Mar., 1908	11·08	,,	11 Feb., 1911	12·00
Somerset	28 Jan., 1903	12·02	,,	2 Apr., 1911	30·65
Southport	14 Mar., 1908	11·05	Yeppoon	31 Jan., 1893	20·05
St. Helena	16 Feb., 1893	11·20	,,	30 Jan., 1896	11·02
St. Helens (Mackay)	24 Feb., 1888	12·00	,,	8 Jan., 1898	18·05
,, ,,	22 Mar., 1898	10·00	,,	8 Apr., 1904	10·70
St. Lawrence	17 Feb., 1888	12·10	,,	3 Feb., 1906	14·90
,,	30 Jan., 1896	15·00	,,	3 Feb., 1911	14·92
Sunnybank	14 Mar., 1908	11·40	Zillmere	14 Mar., 1908	11·00

HEAVY RAINFALLS, NEW SOUTH WALES.

Name of Town or Locality.	Date.	Amount.	Name of Town or Locality.	Date.	Amount.
		inches.			inches.
Albion Park	8 Feb., 1895	10·00	Leconfield	9 Mar., 1893	14·53
Albury	14 Feb., 1898	10·70	Liverpool	23 Feb., 1874	10·39
Alme Dorrigo	22 Jan., 1893	10·27	Macksville*	23 Feb., 1908	10·00
Anthony	28 Mar., 1887	17·14	Madden's Creek	2 Feb., 1908	10·36
,,	15 Jan., 1890	13·13	,,	13 Jan., 1911	18·68
Arnold Grove	28 May, 1889	11·13	Maitland West	9 Mar., 1893	14·79
,,	20 Mar., 1892	10·08	Major's Creek	14 Feb., 1898	12·32
Araluen	14 Feb., 1898	10·51	Marrickville	9 Mar., 1913	10·40
,,	15 Feb., 1898	13·36	Milton	13 Jan., 1911	10·41
Bellawongarah	13 Jan., 1911	10·92	Mittagong	6 Mar., 1893	11·71
Berry	,, ,,	12·05	Morpeth	9 Mar., 1893	21·52
Billambil	14 Mar., 1894	12·94	Mount Kembla	14 Feb., 1898	10·25
Bomaderry	13 Jan., 1911	13·03	,,	2 Feb., 1908	10·27
Bowral	6 Mar., 1893	11·94	,,	13 Jan., 1911	18·25
Bowraville	22 June, 1898	11·50	Mount Pleasant	14 Jan., 1911	10·40
Broger's Creek	14 Feb., 1898	20·05	Myra Vale	14 Feb., 1898	10·00
,,	19 July, 1910	12·22	Nambucca Heads	3 Apr., 1905	10·62
Broger's Creek Upper	13 Jan., 1911	20·83	Nepean Tunnel	14 Feb., 1898	12·30
			Nethercote	14 Jan., 1911	11·32
Bulli Mountain	19 Mar., 1894	10·45	Newcastle	19 Mar., 1871	11·17
,,	13 Feb., 1898	17·14	,,	9 Mar., 1893	11·14
Burwood	28 May, 1889	11·75	,,	24 Feb., 1908	10·02
Camden	11 July, 1904	10·90	Nowra	11 July, 1904	11·50
Camden Haven	22 Jan,. 1895	12·23	Nowra T.O.	13 Jan., 1911	13·00
Canley Vale	28 May, 1889	10·06	Padstow Park	9 Mar., 1913	10·64
,,	20 Mar., 1892	10·85	Parramatta	28 May, 1889	11·94
Castle Hill	28 May, 1889	13·49	,,	20 Mar., 1892	11·01
Cockle Creek	23 Feb., 1908	10·45	Port Macquarie	9 Nov., 1887	10·76
Colombo Lyttleton	5 Mar., 1893	12·17	Port Stephens	9 Feb., 1889	10·15
Condong	27 Mar., 1887	18·66	Prospect	28 May, 1889	12·37
,,	15 Jan., 1890	11·50	Raymond Terrace	28 Sept., 1903	10·32
Cookville	1 Apr., 1892	11·31	Richmond	28 May, 1889	12·18
Coramba	11 June, 1893	10·83	Robertson	14 Feb., 1898	10·00
Cordeaux River	26 Feb., 1873	10·98	,,	10 July, 1904	10·50
,, ,,	3 Feb., 1890	11·51	Robertson P.O.	13 Jan., 1911	10·28
,, ,,	14 Feb , 1898	22·58	Rooty Hill	27 May, 1889	11·85
,, ,,	31 Aug., 1906	10·31	Rylstone	28 May, 1889	10·26
,, ,,	13 Jan., 1911	14·52	Seven Oaks	22 June, 1898	11·06
Cudgen	15 Mar., 1894	10·23	South Head (near Sydney)	29 Apr., 1841	20·12
Dapto West	14 Feb , 1898	12·05			
,,	13 Jan., 1911	10·37	,, ,,	16 Oct., 1844	20·41
Darkes' Forest	8 Feb., 1895	11·10	Springwood	7 Mar., 1894	10·55
Dunheved	28 May, 1889	12·40	Stockyard Mount	13 Jan., 1911	11·54
Eden	4 May, 1875	10·52	Taree	28 Feb., 1892	12·24
Fernmount	2 Feb., 1890	10·36	Terara	26 Feb., 1873	12·57
,,	2 June, 1903	11·29	Tomago	9 Mar., 1893	13·76
Goorangoola	9 Mar., 1893	10·34	Tongarra	9 July, 1904	11·10
Guy Fawkes	2 June, 1903	11·30	Tongarra Farm	14 Feb., 1898	15·12
Helensburgh	13 Jan., 1911	12·20	Towamba	5 Mar., 1893	20·00
Hercynia	28 May, 1889	11·85	Tweed Heads	14 Jan., 1890	10·53
Holy Flat	12 Mar., 1887	12·00	,,	14 Mar. 1894	11·40
,,	28 Feb., 1892	12·24	Trial Bay	9 Mar., 1893	11·13
Jamberoo	14 Feb., 1898	10·92	White Swamp	12 Jan., 1911	10·24
,,	13 Feb., 1911	10·89	Wollongong	26 Feb., 1873	11·00
Kareela	20 Oct., 1902	11·73	,,	5 Apr., 1882	10·00
Katoomba	7 Apr., 1913	10·50	Woolgoolga	11 June, 1893	10·83
Kembla Heights	13 Jan., 1911	17·46	Yellow Rock	14 Feb., 1898	11·69
Kempsey	10 Mar., 1893	10·34			

* 6·50 inches fell in 2 hours.

TABLE OF MEAN MONTHLY AND ANNUAL RAINFALLS AT CAPITALS AND PRINCIPAL TOWNS IN THE COMMONWEALTH.

City.	Latitude.	Longitude.	Height.	Distance from Coast.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	S.	E.	Feet.	Miles.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Port Darwin ..	12° 28′	130° 51′	97	..	15·27	13·05	9·70	4·50	0·75	0·16	0·07	0·11	0·48	2·12	5·21	10·30	61·72
Broome	17° 57′	122° 15′	34	..	4·96	6·35	3·77	1·35	0·41	1·22	0·27	0·04	0·08	0·03	0·93	3·55	22·96
Perth	31° 57′	115° 51′	197	12	0·33	0·31	0·71	1·65	4·88	6·51	6·44	5·55	3·37	2·06	0·76	0·54	33·11
Kalgoorlie (Coolgardie)	30° 45′	121° 30′	1,261	387	0·33	0·61	0·82	0·69	1·41	1·18	0·92	0·93	0·55	0·79	0·45	0·59	9·27
Alice Springs ..	23° 38′	133° 37′	1,926	576	1·68	1·73	1·24	0·90	0·60	0·57	0·46	0·40	0·41	0·72	0·90	1·32	10·93
Adelaide	34° 56′	138° 35′	140	6	0·74	0·60	1·07	1·88	2·77	3·09	2·66	2·51	1·94	1·75	1·13	0·94	21·08
Broken Hill	30° 58′	141° 21′	1,001	220	0·79	0·81	0·63	0·75	0·91	1·22	0·65	0·98	0·69	0·84	0·59	0·79	9·65
Bendigo	36° 46′	144° 17′	825	73	1·37	1·04	1·55	1·67	2·12	2·73	2·01	2·21	2·05	2·04	1·52	1·19	21·50
Ballarat	37° 33′	143° 52′	1,430	46	1·70	1·34	2·01	2·46	2·92	3·10	2·59	2·86	2·94	2·76	2·26	1·82	28·76
Geelong	38° 10′	144° 21′	90	1	1·34	1·24	1·63	1·83	1·96	2·03	1·49	1·60	1·89	1·84	1·68	1·19	19·72
Melbourne	37° 50′	144° 59′	115	3	1·85	1·74	2·18	2·32	2·15	2·11	1·86	1·81	2·35	2·64	2·20	2·30	25·51
Hobart	42° 53′	147° 22′	160	1	1·80	1·45	1·65	1·80	1·91	2·22	2·10	1·83	2·14	2·24	2·50	1·93	23·57
Launceston	41° 27′	147° 10′	33	32	1·96	1·10	1·85	2·07	2·54	3·45	2·99	2·77	2·97	2·61	1·81	2·04	28·16
Canberra	35° 20′	149° 15′	1,910	60	2·46	1·78	1·97	1·63	1·69	1·94	1·31	1·53	1·80	2·28	2·20	2·06	22·65
Bulli (Wollongong) ..	34° 25′	150° 56′	33	..	4·04	4·94	4·14	4·92	3·86	4·59	3·26	2·77	2·77	2·77	2·69	2·90	43·65
Sydney	33° 52′	151° 12′	146	5	3·67	4·70	5·07	5·24	4·95	5·18	4·68	3·29	2·89	2·82	2·91	2·60	48·00
Newcastle	32° 55′	151° 49′	112	1	3·50	4·60	5·46	4·42	4·83	4·17	4·44	3·42	3·26	2·98	2·87	3·23	47·18
Maitland	32° 45′	151° 35′	19	18	3·23	3·64	3·94	2·72	2·45	2·52	2·67	2·42	2·66	2·27	2·42	2·84	33·78
Brisbane	27° 28′	153° 2′	137	10	6·66	6·63	6·20	3·64	2·92	2·62	2·33	2·35	2·05	2·78	3·65	5 12	46·95
Rockhampton ..	23° 24′	150° 30′	37	18	9·26	8·36	5·43	2·44	1·63	2·03	1·63	1·01	1·38	1·72	2·17	4·04	41·10
Thursday Island ..	10° 34′	142° 12′	17	..	18·15	17·29	14·36	8·01	1·65	0·47	0·30	0·22	0·10	0·29	1·29	5·76	67·89

Western Australia.

The heaviest rainfall occurs over the south-western portion of the State, which has a long coast-line exposed to the Indian Ocean and the full force of the westerly winds of southern latitudes, and the rainfall there and in fact over the south-western half of the State, except the eastern gold-fields, is a winter one, 80 to 90 per cent. of the annual totals, in the south-western agricultural areas, falling during the growing period, April to October. From the coast for about 80 to 100 inland miles the rainfall decreases rather rapidly, but the area in the south-west over which 15 or more inches fall amounts to 74,206 square miles.

The rapid decrease from the west coast inland is partly accounted for by the range of hills which runs parallel to the coast from the extreme south to beyond the Murchison River, although they are not of sufficient elevation to serve as a natural store for precipitation in the form of snow. At some places on the southern portions of these hills, the annual rainfall exceeds 42 inches, about 10 more than on the coast. Inland, owing to the vast extent of land between the gold-fields and the South Australian boundary, over which the easterly winds pass, the evaporation is very great, amounting to about 87 inches annually at Coolgardie, while on the coast, at Perth, it is 66 inches.

The full effects of the westerly winds of southern latitudes are apparently not felt beyond lat. 27 degrees, just reached by the 15-in. isohyet, and from there to the tropic the rainfall is scanty and occasionally amounts to only 3 or 4 inches in the year.

From that isohyetal inland, towards the Murchison and North Coolgardie gold-fields, the records only extend back some ten or fifteen years, but it is not likely that longer records will show a much larger annual rainfall. The 10-in. isohyet which skirts Peak Hill and Wiluna is probably doubtful, and may ultimately have to be modified, as the record used in obtaining the average rainfall at these two stations was very largely inflated by the abnormal falls in March and April, 1900, and January and February, 1902, when Peak Hill registered 18·13 and 14·56 respectively, and Wiluna 22·82 and 9·69 inches.

North of the Tropic, the Kimberley district receives good tropical rains during the summer months, from November to March or April, but the De Grey and Fortescue districts are dependent for their rainfall partly on the tropical storms, commencing about December, and partly on the winter rains from the Indian Ocean, but the total amounts are smaller than those in the Kimberley district, and very variable, as sometimes both the tropical and southern winter rains fail, and at other times phenomenal falls occur during the "willy willy" season, *e.g.*, Whim Creek registered 36·53 inches on three days in April in 1898.

The areas in Western Australia receiving varying quantities of rainfall, as shown on the map, are as follows:—

——	Area in Square Miles.		
	Tropical, North of Tropic.	Rest of Western Australia, South of Tropic.	The Whole State.
Over 40 inches	..	3,376	..
From 30 to 40 inches	28,940	11,810	..
" 25 " 30 "	36,973	7,127	..
" 20 " 25 "	36,693	14,611	..
" 15 " 20 "	52,640	37,282	..
" 10 " 15 "	153,870	78,945	..
Under 10 inches	..	..	513,653
Total	309,116	153,151	513,653

South Australia.

The main factors which determine the rainfall distribution of South Australia are the proximity of the Southern Ocean and the long extent of coast line exposed to the free and unrestricted sweep of the westerly winds nautically known as the roaring forties; the rainfall over all the coastal areas is essentially a winter one, and practically all available for agricultural purposes, as from 70 to 90 per cent. of the annual totals in the more settled areas, falls during the growing period, April to October.

Though physiographic influence is less apparent than in south-eastern Australia, the effect of elevation is marked by the heavier rainfalls on the eastern sides of Spencer's Gulf and Gulf St. Vincent, and by the northerly extension of the 10-in. isohyetal from Port Augusta to beyond Blinman. The abundant rain on the Mount Lofty ranges to the east of Adelaide are a conspicuous example of this, the annual total on the crest of the range reaching to nearly 47 inches.

A rapid decrease of the rainfall takes place from the agricultural areas northwards to the interior, where, in the Lake Eyre basin, which is below sea-level, the average annual fall—largely made up of capricious summer storms—is under 5 inches, this district being probably the driest part of the continent.

In the Northern Territory the chief factor in the distribution of the rainfall, which is almost entirely confined to the six summer months, is latitude or distance from the north coast—the rains being abundant on the coast, but rapidly decreasing towards the interior.

The areas in South Australia and the Territory enjoying varying quantities of rainfall, as shown on the map, are as follow:—

Rainfall.	Area in Square Miles.	
	South Australia.	Northern Territory.
Over 40 inches	64	46,780
From 30 to 40 inches	934	40,690
„ 25 „ 30 „	3,197	47,580
„ 20 „ 25 „	10,630	45,890
„ 15 „ 20 „	14,190	62,920
„ 10 „ 15 „	33,405	141,570
Under 10 inches	317,600	138,190
Total	380,070	523,620

Queensland.

The eastern littoral of Queensland from Cape York to the Tweed receives an annual average rainfall of about 60 inches. On parts of the north coast, between Cooktown and Townsville, this increases to 150 and 165 inches per annum. The main source of supply is the south-east trade wind, and local variations in totals are solely due to differences in elevations of the shore line.

On the Peninsula the rainfall ranges from 69 inches at Cape York to 32 inches at Georgetown; in lower Carpentaria, it averages about 25 inches.

In the central districts the average varies from 30 inches on the eastern boundary to 20 inches on the western.

In the Maranoa it averages about 23 inches, and over the Darling Downs from 25 to 30 inches. In the Warrego, it varies from 15 to 20 inches, and in the far western districts from 15 inches down to 6 inches at Birdsville, in the extreme south-west corner.

During the wettest months of the year, viz., January, February, and March, very heavy daily falls over the eastern areas are not by any means infrequent. A fall of 10 inches and over in the 24 hours has been recorded on many occasions. On 2nd February, 1893, 35·71 inches were measured at Crohamhurst; this constitutes one of the world's records for heavy rainfall. On that occasion the total measurement for the four days ending 3rd February was 77·305 inches, or nearly 6½ feet.

The following table shows the areas in square miles of varying quantities of rainfall:—

Rainfall	Area in Square Miles.
Over 80 inches	2,826
From 70 to 80 inches	2,379
,, 60 ,, 70 ,, ...	10,261
,, 50 ,, 60 ,, ...	18,167
,, 40 ,, 50 ,, ...	60,466
,, 30 ,, 40 ,, ...	80,556
,, 25 ,, 30 ,, ...	100,137
,, 20 ,, 25 ,, ...	118, 91
,, 15 ,, 20 ,, ...	116,790
,, 10 ,, 15 ,, ...	97,722
Under 10 inches	62,805
Total	670,500

New South Wales.

Proximity to the ocean, with prevailing winds of favorable direction, is, in all countries, the chief factor accounting for the greatest totals being generally recorded along the coast line. New South Wales shows no exception to this law, but it is noticeable that nearly all the districts near the coastal rivers show a depressed rainfall in comparison with surrounding and naturally higher country.

Starting from the northern border, the 50-in. isohyetal line at Casino, on the Richmond River, deviates slightly towards the sea line; and the same feature may be noted, in a more or less marked degree, on the Clarence, Macleay, Manning, Hunter, and Shoalhaven Rivers; while the Nepean Valley can be traced right through from Picton to the Hawkesbury by its relatively light rainfall.

On the northern tablelands the higher levels enjoy falls well over 30 inches. The extension of that isohyet encloses a narrow tongue-shaped area, reaching in a south-westerly direction from Inverell to Lindsay, owing to the elevation of this area being higher than that of the country on its west and south boundaries.

The series of short ranges, reaching from Murrurundi to the Warrumbungle, can be readily followed by the relatively higher rainfall figures.

Further south, the Blue Mountains are particularly conspicuous, also the Canobolas. The extension of the Australian Alps, which almost entirely feed the Murrumbidgee, and contribute largely to the constant flow of the Murray, stands out in clear relief. Although a considerable distance from the coast, the elevation is such as to modify the disadvantage resulting therefrom; and not only is abundant moisture extracted from the winds from off the east coast, but considerable condensation takes place on the western aspect from the south-west winter winds after they have swept across nearly the whole length and breadth of Victoria.

The comparatively light rainfall in the district extending from Delegate to Yass, and conspicuously so between Bobundra and Michelago, is one of the most remarkable features of the rainfall map of Australia. Although the greater part of this district is considerably over 2,000 feet high, it is enclosed by ranges of mountains rising to 3,000 and 5,000 feet, which condense from all directions moisture that would otherwise benefit it.

It may be added that, although the falls over this area do not exceed 25 inches, yet it is remarkably productive, for the reason that evaporation is relatively small, and that a vast quantity of soakage must find its way there from the encompassing ranges.

The Sydney and Burrinjuck water supply catchment areas receive annual totals ranging from 30 to 60, and from 20 to 60 inches respectively.

The areas in New South Wales, enjoying varying quantities of rainfall, are shown in the following table:—

Rainfall.	Area in Square Miles.
Over 70 inches	668
From 60 to 70 inches	1,765
„ 50 „ 60 „	4,329
„ 40 „ 50 „	15,804
„ 30 „ 40 „	30,700
„ 20 „ 30 „	77,202
„ 15 „ 20 „	57,639
„ 10 „ 15 „	77,268
Under 10 inches	44,997
Total	310,372

Victoria.

A casual glance at the rainfall map of Victoria will again indicate the great control exercised in rainfall distribution over the earth's surface by the mountains and proximity to the seashore. In regard to the latter factor, it will be noticed that the isohyets generally follow the contour of the coast line, and in the former the heaviest records are coincident with the highest mountains of the State.

The abundant rains on the Australian Alps, the Cape Otway ranges, and the Gippsland ranges are particularly conspicuous. In a less striking manner is shown the precipitating effect of the Central Dividing Range and the Grampians. The relatively depressed areas to the north and west of Melbourne suffer in regard to the comparative smallness of their rainfall through the effect of the higher surrounding country on rain-bearing winds. A similar effect is noticeable in the Latrobe, Thomson, Tambo, and Mitta Mitta Valleys.

While contending that the rainfall over the eastern portion of Australia is in no wise short of that experienced in other continents, we must not lose sight of the fact that our mountain chains are not sufficiently high, nor have they the extent of area, to compensate for Australia's deficiency of rainfall in the areas far removed from the coast, *i.e.*, they are not of sufficient elevation to serve as a natural store for precipitation in the form of snow, and also that the loss of moisture by evaporation is abnormal. It is, therefore, imperative, if equalizing results are to be obtained from the capriciousness of our rainfall seasons, that artificial storage in reservoirs at the catchments be resorted to, and all rivers, particularly those inland, dammed and locked as a national policy of paramount importance, and, further, that the waters in rivers, lakes, and reservoirs, be protected from desiccating winds by the liberal planting of trees.

In studying the distribution of rainfall, as depicted on the map, we find that the areas in Victoria enjoying varying quantities of rainfall per annum are as follow :—

Rainfall.	Area in Square Miles.
Over 60 inches	1,597
From 50 to 60 inches	3,348
„ 40 „ 50 „	7,055
„ 30 „ 40 „	14,029
„ 25 „ 30 „	15,247
„ 20 „ 25 „	14,070
„ 15 „ 20 „	12,626
Under 15 inches	19,912
Total	87,884

Tasmania.

In the West Coastal district and the north-east, the rainfall varies so very much that until records are available for a long series of years, the isohyets are bound to be considerably altered at the end of each year.

The extremes and means are shown in the following table, viz. :—

——	Highest.	Lowest.	Mean.
	Inches.	Inches.	Inches.
North-east district, Springfield	86·84	36·81	57·68
Western district—			
Waratah	117·24	59·97	85·52
Mount Read	145·04	70·38	110·45

The most striking feature in these parts of the island is the great variation shown for such a comparatively small area between the greatest and least average falls, viz., from 17·93 inches at Beaufront (Ross), to 115·82 at Mount Lyell on the West Coast, showing a range of 97·89 inches. This accentuates the great control exercised upon the rainfall by the physiographic conditions and proximity to the seashore.

The West Coast, being exposed to the full sweep of the moisture-laden westerly winds, and condensation being assisted by altitudes of between

3,000 and 5,000 feet, experiences frequent rains, and, as may be seen by a glance at the map, high annual averages, over 100 inches in places, are the result.

The effect of altitude is again noticeable in the south-east, where Hobart, at an elevation of 160 feet, has an annual rainfall of 23·57 inches, while Mount Wellington, at the 2,500-ft. level, totals 60·34 inches.

The heavy rains experienced in the north-east are similar in character to those on the coast of New South Wales and eastern Victoria, and the south-east winds exercise a certain amount of control over the rainfall of this portion of the island.

The areas in Tasmania enjoying varying quantities of rainfall, as shown on the map, are as follow:—

Rainfall.		Area in Square Miles.
Over 100 inches		553
From 80 to 100 inches		1,235
„ 60 „ 80 „		2,097
„ 50 „ 60 „		2,767
„ 40 „ 50 „		3,449
„ 30 „ 40 „		4,588
„ 20 „ 30 „	Mainland	6,035
	King, Flinders, and other Islands	1,524
Under 20 inches		937
Total		23,185
No records available—		
In south-west of Mainland		2,927
On Islands of North-west Group		103
Grand Total Area		26,215

Bruni Island has been included with the Mainland.

8. Rainfall During the Wheat-growing Period.

In Australia wheat-growing under ordinary conditions is generally considered a safe and payable proposition when 10 inches of rain and over falls from the month of April to that of October inclusive.

The accompanying map (Fig. 9) has been compiled for the purpose of showing what portions of the continent are favoured with the above requirements.

There are in all 484,330 square miles of country with 10 inches of rainfall and over during the wheat-growing period, distributed as follows:—93,500 square miles in Western Australia, 46,980 square miles in South Australia, 79,247 square miles in Queensland, 163,772 square miles in New South Wales, 74,616 square miles in Victoria, and 26,215 square miles in Tasmania.

Much of these areas, however, is unsuitable, probably half the total, by reason of excessive rains, early summer rain, topography and soil, but as compensation there are vast tracts of interior land possible for cereal growth by the adoption of drought resisting seed and dry farming methods, which, in all probability, may still give the estimated 500,000 square miles or even more for wheat cultivation.

During the year 1912–13 there were only 11,247 square miles, less than half the area of Tasmania, under wheat, yielding 88,554,738 bushels. This is approximately only one-third of the area at present used for this purpose, allowing for land under fallow and rotation of crops. Estimating, therefore, that only a third of the 500,000 would be available each year for wheat cultivation, the possible output from Australia could reach 900 to 1,000 million bushels.

From the trend of developments during the last few years it would appear that the greatest scope for expansion in wheat production is in New South Wales and Western Australia.

The boundary of the 10-in. wheat period isohyet starts on the west coast of Western Australia, a few miles to the south of Hamelin Pool, thence passes inland in a south-easterly direction towards Southern Cross, from there almost due east, entering the Great Bight to the north of Israelite Bay. It again enters the mainland between Fowler's Bay and Streaky Bay, in South Australia, curving south-eastwards from Yardea to Spencer's Gulf to the north of Cowell, and crossing the Gulf it strikes the Peninsula near Port Pirie, forming a loop over the country well to the north of Port Augusta, whence it takes a sinuous course southwards through the lower Mallee to the north-east Wimmera, crossing the Murray in a north-easterly direction to the west of Deniliquin in Riverina, then over the Murrumbidgee at Darlington Point, from there bending northwards and passing successively near Mount Hope, Nymagee, Coonamble, Walgett, to Munigindi, whence it extends almost in a direct line northwards, finally leaving the Queensland coast at Bowen.

It will be noticed how remarkably closely the 10-in. and Goyder's line follow one another in South Australia.

In New South Wales, however, there are considerable deviations between Coghlan's and the 10-in. wheat lines.

Goyder's line was determined in 1865 by Mr. G.W. Goyder, the Surveyor-General of the then colony, based upon the estimated average rainfall and native flora.

Coghlan's line was determined by Mr. T. Coghlan, State Statistician, in 1903, based upon rainfall data and the actual experience of growers.

The percentage lines of the wheat-growing period in relation to the annual average rainfall are of considerable interest, and emphasize the alternating distinct wet and dry season in Australia already referred to.

Roughly speaking, from 60 to 70 per cent. of the annual total precipitation falls over southern Australia during the seven coldest months, and from 30 to 40 per cent. during the hottest months. North of the tropic the quantitative distribution is reversed, only 10 to 40 per cent. falling during the cold months and from 60 to 90 per cent. during the hot months.

In the south-western portion of Western Australia, it will be observed that 90 per cent. of the annual average rainfall is precipitated in the winter and 10 per cent. only during the summer months.

On the south-eastern shores of the Gulf of Carpentaria we have the other extreme—only 5 per cent. of the year's rainfall total falls within the seven cold months mentioned, and 95 per cent. during the remaining five.

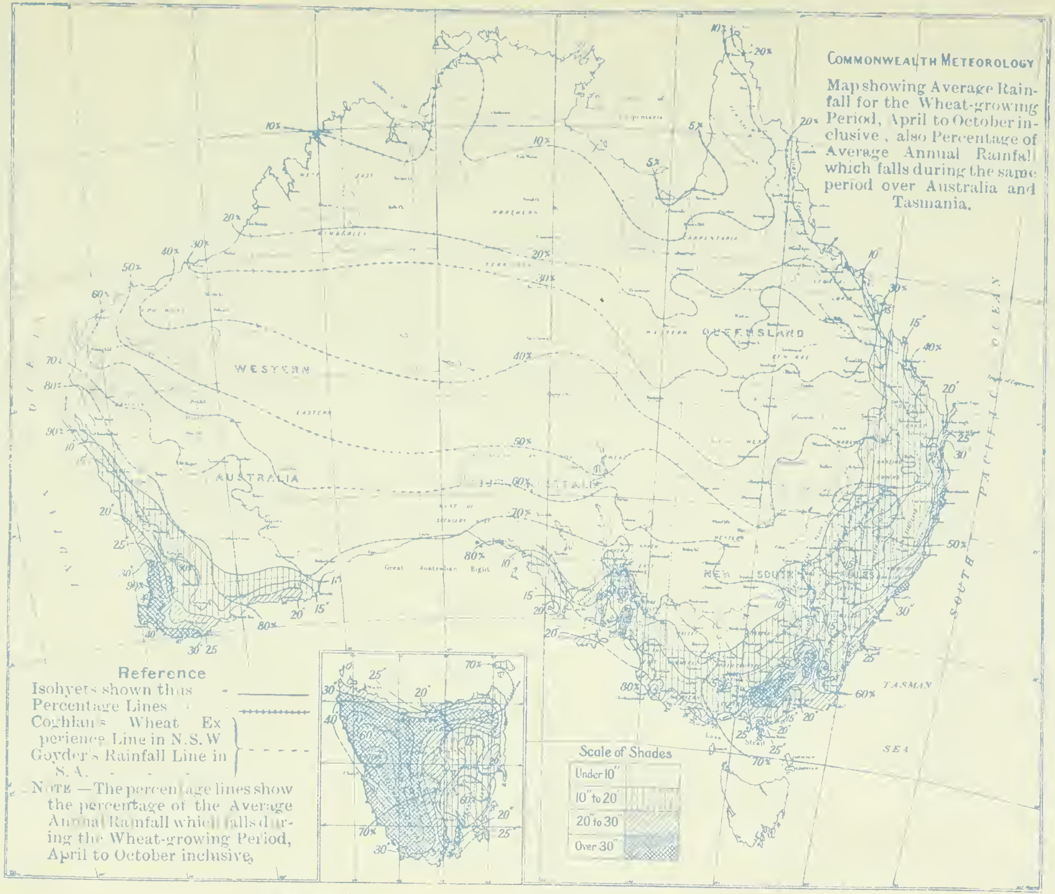
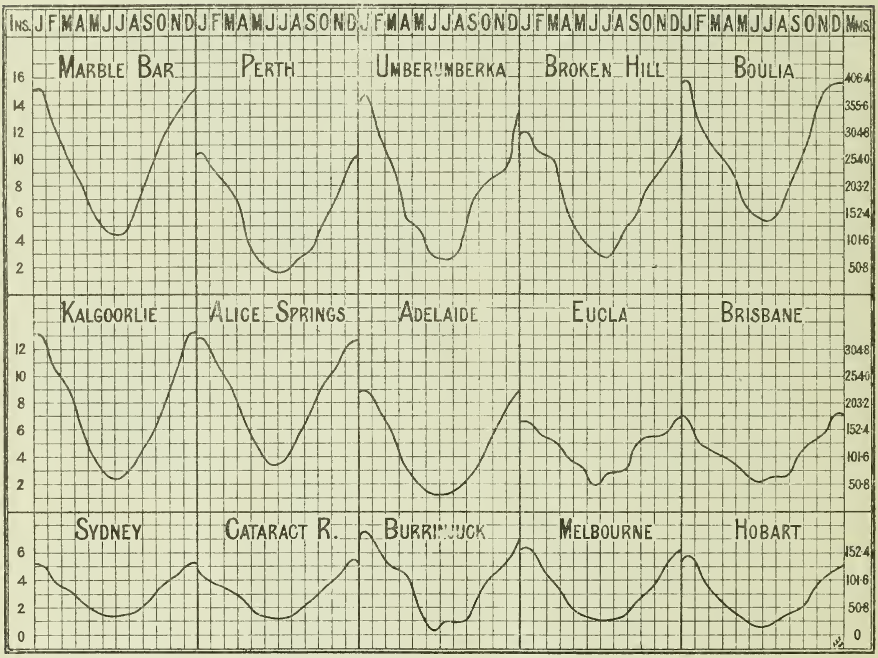

COMMONWEALTH METEOROLOGY
Map showing Average Rainfall for the Wheat-growing Period, April to October inclusive, also Percentage of Average Annual Rainfall which falls during the same period over Australia and Tasmania.
Reference
Isohyets shown thus
Percentage Lines
Coghlan's Wheat Experience Line in N.S.W
Goyder's Rainfall Line in S.A.
NOTE.—The percentage lines show the percentage of the Average Annual Rainfall which falls during the Wheat-growing Period, April to October inclusive.
Scale of Shades
Under 10"
10" to 20"
20" to 30"
Over 30"
WESTERN
AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
Great Australian Bight
SOUTH PACIFIC OCEAN
TASMAN SEA
10%
20%
30%
40%
50%
60%
70%
80%
90%
5%
15
20
25
30

Fig. 9.—Average Rainfall for Wheat-growing Period.

Graph showing Mean Monthly Evaporation at Selected Stations.



NOTE.—Each vertical space represents 1 inch or 25·4 millimetres.

FIG. 12.

9. Snow.

Perennial snow occurs only over the sheltered crevices in the highest portions of the Australian Alps, where, however, during the winter months it accumulates to a depth of many feet, and by gradual thawing maintains a constant flow of water to the Murray and Snowy Rivers throughout the year.

During the winter period snow can always be expected along the mountain ranges in New South Wales, Victoria, and Tasmania, and occasionally on the Mount Lofty ranges, in South Australia. On rare occasions also it has reached as far north as Toowoomba, in Queensland, latitude 27° 28′ S.

Over the plain country it has been known to fall as far west as Louth, on the Darling River, over the whole of eastern and southern Victoria, except the immediate coast line. In South Australia it has been recorded over a belt of country lying to the east of Spencer's Gulf, about 200 miles long, running from north to south and 75 miles wide. It has only been noted at one place to the west of the Gulf, viz., at Yardea, near Lake Gardner.

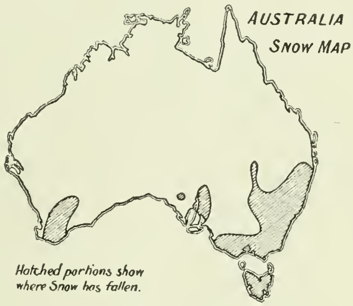


FIG. 10.

In Western Australia it has been recorded on the hills in the extreme south-west, and at a few places on the southern gold-fields.

The heaviest snowstorm on record in New South Wales occurred between 3rd and 7th July, 1900, extending from Congewar in the Hunter district to Condobolin and Warrumbungle, in the west. Railway traffic became paralyzed, passengers being shut up in carriages and unable to reach hotels. In places the snow was 8 feet deep on the rails. At Bathurst, many roofs, verandahs, etc., collapsed under its weight, while telegraph lines were levelled everywhere.

In 1901, on 28th July, the most widespread snowstorm occurred over south-eastern Australia, being practically general east of the 145th meridian. Another remarkable storm on the 29th and 30th August, 1905, extended from South Australia through southern Victoria along the highlands of New South Wales to within 30 miles of the Queensland border.

On the mainland Sydney and Melbourne are the only two capital cities that possess authenticated records of appreciable snow falls. In Sydney on June 30th, 1836, snow fell for half-an-hour, sufficient being on the ground to enable boys to make snowballs.

Melbourne was covered with snow 7 to 12 inches deep on the morning of the 31st August, 1849. Another remarkable fall took place on the 7th August, 1899, between 1 and 2 p m., when snow fell heavily in the Fitzroy Gardens, and snowballing was indulged in at the Scotch College. A light to heavy fall also occurred over the north-eastern suburbs of Melbourne between 7 and 8 a.m. on the 25th September, 1905. Flakes of snow were observed in, or close to, Melbourne on 14th July, 1840, 27th June, 1845, 26th July, 1882, 28th June, 1900, 18th April, 1910, and 21st June, 1911.

10. Evaporation.

The problems which inevitably face the engineering work of water conservation for the development and expansion of Australia's as yet unused territory demand that the fullest knowledge possible respecting the rate and distribution of evaporation (a climatic element second in importance to rainfall only) should be available.

For the purpose of obtaining data on this subject a number of iron jacketed tanks 3 feet in diameter have been distributed to several selected centres.

The tops of the tanks are sunk to within an inch of the surface level of the ground. They contain about 130 gallons of water, which is replenished when or before a fall of 6 inches from the top of the tank takes place, in order that the exposed level may be fairly constant and also that the added water may not materially affect the temperature of the main body.

Information collected up to the present is not very extensive, nor do the observations in some cases extend over many years, but sufficient has been obtained to approximate roughly the times of equal evaporation and the aggregate annual amounts in different parts of the continent.

The results deduced from observations carried out at the capital cities over a great number of years establish the rate and total evaporation taking place over coastal regions south of the tropic. At coastal stations north of the tropic, viz., Rockhampton, Cooktown, Thursday Island, Port Darwin, the annual totals have been computed with Fitgzerald's formula :—

$$E = [\cdot 014\ (V - v) + \cdot 0012\ (V - v)^2]\ [1 + \cdot 67w^{\frac{3}{5}}].$$

Marble Bar, Alice Springs, Boulia, and Broken Hill furnish results for the interior. Those at Broken Hill were undertaken at the Stephen's Creek Reservoir by Mr. Whitehead, the engineer of the silver city, and give the actual loss of water from the extensive artificial lake. It is satisfactory to note that the record from the standard tank at the Umberumberka site but a few miles away gives only a difference of 3·399 inches for the twelve months.

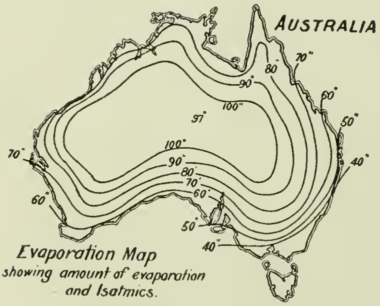


FIG. 11.

It will be seen by reference to the accompanying table and chart that about a third of the continent, almost coincident with that portion having but an average annual rainfall of 10 inches and under, loses from exposed water 100 inches and over per annum.

The daily rate of evaporation during the summer months is considerable, more especially inland, where from ½ to ¾ of an inch daily is a common occurrence, and at times up to an inch and over, hence, if it is desired to receive any benefit from showers, any possible means that can be adopted to break the surface soil, and so let the rain through, must be resorted to, even on grazing land

TABLE OF MEAN MONTHLY AND ANNUAL EVAPORATION AT STATIONS IN THE COMMONWEALTH.

Station.	Latitude.	Longitude.	Distance from Coast.	Number of Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	S.	E.	Miles.		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins,	Ins.	Ins.	Ins.
Marble Bar.. ..	21° 11′	119° 42′	75	..	15·109	12·918	10·355	8·337	5·922	4·682	4·383	6·113	8·650	11·303	13·033	14·533	115·338*
Perth	31° 57′	115° 51′	12	14	10·39	8·76	7·67	4·84	2·65	1·69	1·63	2·35	3·30	5·27	7·72	9·86	66·13
Kalgoorlie (Coolgardie)	30° 45′	121° 30′	387	2	13·09	10·62	9·29	6·18	3·78	2·48	2·48	3·55	5·33	7·49	10·35	13·10	87·74
Alice Springs ..	23° 38′	133° 37′	576	20	12·729	10·875	9·538	6·863	4·868	3·391	3·659	5·135	7·296	9·558	10·939	12·252	97·103
Boulia	22° 55′	139° 38′	356	1	15·692	12·243	10·691	9·4 9	6·877	5·806	5·416	6·670	9·311	11·735	15·044	15·589	124·513*
Adelaide	34° 56′	138° 35′	6	42	8·965	7·297	5·773	3·399	1·980	1·224	1·289	1·846	2·822	4·732	6·565	8·395	54·287
Umberumberka ..	31° 47′	141° 13′	210	1	14·718	12·023	9·400	5·562	4·775	2·760	2·587	3·390	6·721	8·126	8·897	11·559	90·518
Broken Hill ..	30° 58′	141° 21′	220	4	11·918	10·325	9·836	6·331	4·026	3·325	2·739	4·184	5·364	7·781	9·069	10·738	85·636
Melbourne	37° 50′	144° 59′	3	40	6·343	5·007	3·877	2·350	1·463	1·100	1·046	1·470	2·253	3·273	4·500	5·700	38·382
Hobart	42° 53′	147° 22′	1	3	5·738	4·176	2·880	1·991	1·211	0·644	0·783	1·280	1·734	2·904	4·176	4·861	32·378
Burrinjuck ..	34° 59′	148° 36′	118	1	7·565	6·192	4·930	4·333	1·961	0·359	0·995	0·943	2·053	3·821	4·791	5·855	43·798
Cataract River ..	34° 15′	150° 46′	12	6	5·260	3·701	3·207	2·539	1·579	1·260	1·196	1·678	2·479	3·443	4·201	5·497	36·040
Sydney	33° 52′	151° 12′	5	33	5·101	3·960	3·350	2·453	1·629	1·360	1·413	1·718	2·560	3·710	4·404	5·258	36·916
Brisbane	27° 28′	153° 2′	10	3	6·492	4·846	4·352	3·826	2·952	2·192	2·422	2·479	3·900	4·989	5·720	7·089	51·259
Rockhampton ..	23° 24′	150° 30′	18	..	..	..	..	..	..	..	..	..	..	..	..	..	58·†
Cooktown	15° 28′	145° 17′	..	..	..	..	..	..	..	..	..	..	..	..	..	..	54·†
Thursday Island ..	10° 34′	142° 12′	..	..	..	..	..	..	..	..	..	..	..	..	..	..	77·†

* Some amounts estimated.
† Estimated.

11. Barometric Pressure.

South of a line joining Perth and Rockhampton the annual average pressure is 30 inches. To the north of that line it gradually diminishes to 29·80 near Cambridge Gulf, on the extreme north-west coast.

In January the average pressure over Southern Australia varies from 29·85 to 29·90, and in Northern Australia from 29·70 to 29·80 inches.

In July south from the tropic the average is from 30·10 to 30·15, and north of it from 30·10 to 29·90.

Over the northern half of the continent only one monthly maximum and minimum of pressure is noticeable, viz., in July and January respectively, but over the southern half there are two minima which become increasingly marked as the south-east corner of the continent is approached. These minima occur in May and July.

Throughout the year there is generally shown a concentration of pressure over the south-eastern quarter of the continent and the reverse in the north-western quarter.

TABLE OF MEAN MONTHLY AND ANNUAL BAROMETRIC READINGS, REDUCED TO 32° F., M.S.L., AND STANDARD GRAVITY AT CAPITALS AND PRINCIPAL TOWNS IN THE COMMONWEALTH.

—	Height above sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	Feet.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches
Port Darwin ..	99	29·699	29·708	29·745	29·793	29·849	29·878	29·896	29·890	29·863	29·826	29·780	29·725	29·804
Broome	34	29·721	29·731	29·758	29·847	29·920	29·950	29·962	29·951	29·908	29·860	29·792	29·748	29·846
Perth	197	29·911	29·927	29·990	30·074	30·079	30·065	30·096	30·088	30·057	30 034	29·994	29·932	30·021
Kalgoorlie ..	1,261	29·866	29·900	29·968	30·069	30·106	30·092	30·118	30·104	30·026	29·968	29·912	29·858	29·999
Alice Springs ..	1,926	29·707	29·734	29·849	29·983	30·071	30·103	30·127	30·058	29·976	29·887	29·804	29·741	29·920
Adelaide ..	140	29·914	29·951	30·039	30·116	30·123	30·098	30·133	30·100	30·042	29·997	29·974	29·919	30·034
Broken Hill ..	1,001	29·875	29·905	29·962	30·120	30·154	30·163	30·114	30·142	30·042	30·030	29·934	29·860	30·025
Bendigo	825	29·890	29·936	30·025	30·104	30·132	30·106	30·135	30·100	30·023	29·976	29·943	29·883	30·021
Ballarat	1,430	29·903	29·947	30·042	30·113	30·079	30·088	30·112	30·065	30·015	29·984	29·950	29·901	30·017
Geelong	90	29·968	30·001	30·010	30·099	30·126	30·122	30·072	30·062	29·985	30·002	29·984	29·882	30·026
Melbourne ..	115	29·913	29·962	30·037	30·101	30·106	30·078	30·097	30·067	29·996	29·965	29·952	29·896	30·014
Hobart	160	29·832	29·918	29·941	29·945	29·992	29·955	29·929	29·931	29·839	29·832	29·799	29·803	29·893
Launceston ..	33	29·926	29·968	29·942	29·997	30·006	30·004	30·017	29·984	29·864	29·868	29·876	29·715	29·931
Bulli (Wollongong)	33	29·923	29·885	30·037	30·092	30·136	30·092	30·080	30·089	30·019	29·988	29·978	29·905	30·027
Sydney	146	29·901	29·943	30·020	30·073	30·082	30·060	30·079	30·076	30·016	29·966	29·953	29·881	30·004
Newcastle ..	112	29·915	29·961	30·038	30·095	30·107	30·082	30·109	30·103	30·041	30·002	29·974	29·905	30·028
Brisbane ..	137	29·898	29·923	29·990	30·083	30·136	30·101	30·110	30·138	30·080	30·045	30·003	29·922	30·036
Rockhampton ..	37	29·835	29·858	29·929	30·042	30·103	30·105	30·122	30·134	30·085	30·043	29·991	29·895	30·012
Thursday Island ..	17	29·767	29·782	29·799	29·829	29·880	29·986	29·913	29·926	29·918	29·892	29·854	29·810	29·856

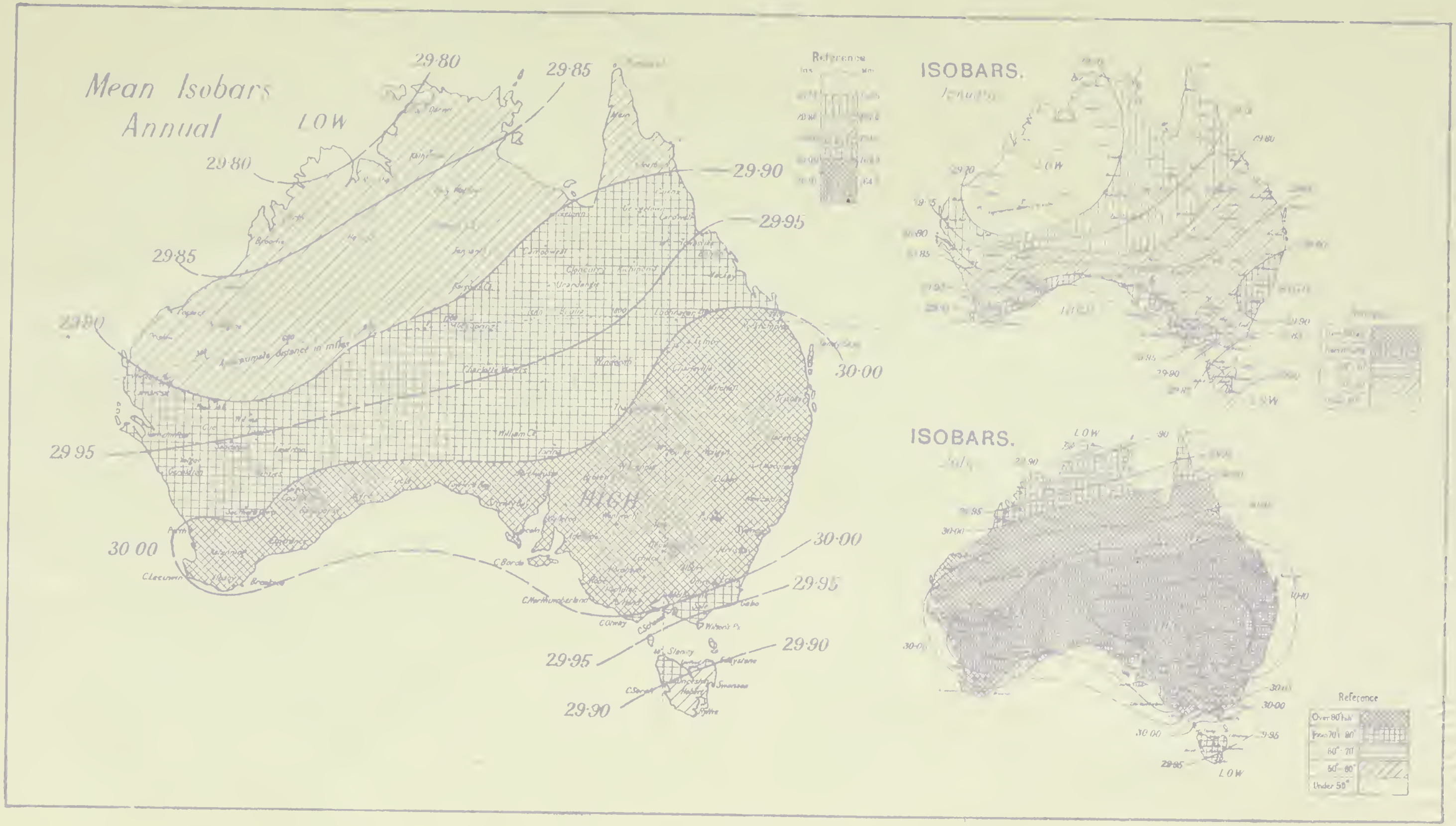
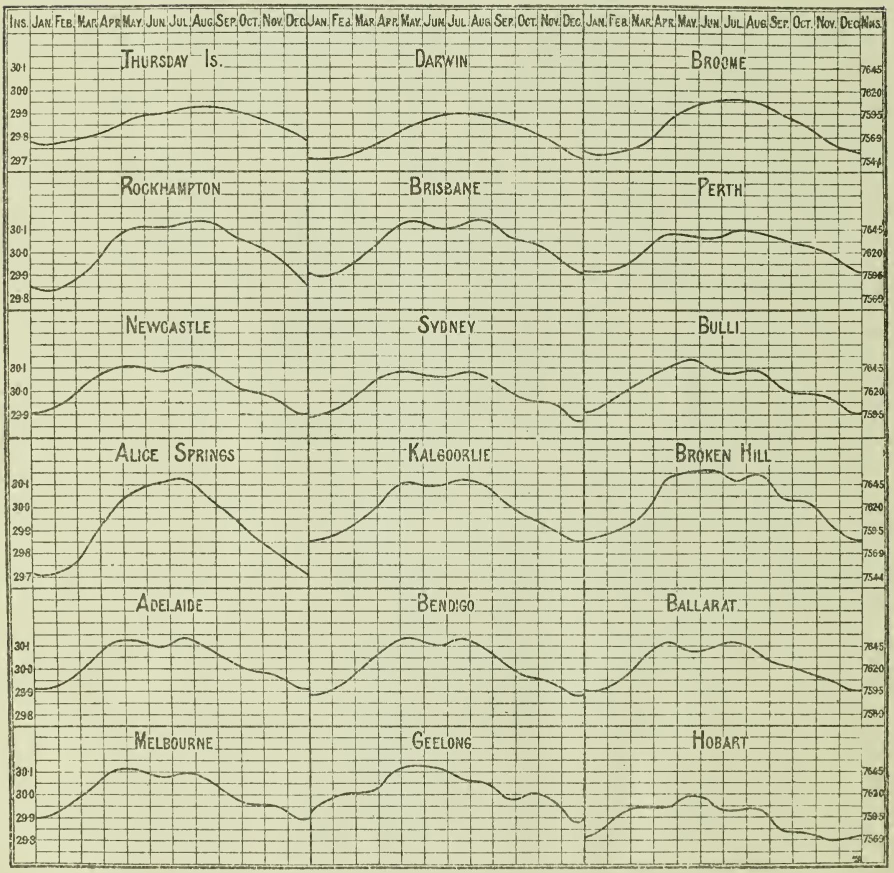

Mean Isobars
Annual
LOW
HIGH
29·80
29·85
29·90
29·95
30·00
Reference
ISOBARS.
January
LOW
ISOBARS.
July
LOW
Reference
Over 80° Fahr.
From 70° to 80°
60°–70°
50°–60°
Under 50°
C. Leeuwin
C. Borda
C. Northumberland
C. Otway
Wilson's Pr.
C. Sorell
Hobart
Perth
Broome
Launceston
Swansea

FIG. 13.

Graph showing Mean Monthly Atmospheric Pressure of Principal Cities in Australia.



NOTE.—Each vertical space represents ·05 of an inch or 1·26 millimetres.

FIG. 14.

12. Winds.

The most conspicuous winds of Australia are the south-east trades which blow almost continuously over the northern half of the continent, and the westerly winds, or " roaring forties," which, during the winter months, extend northwards over the whole of the southern areas. Both these winds, however, are strongly deflected by continental or monsoonal influences, so much so that in summing up the average prevailing direction of wind in different parts of Australia, particularly over the southern portions, these two great systems of wind circulation are almost obscured.

On the south coastal areas, for example, we find that the average prevailing direction has a strong southerly component during the summer months and northerly component during the winter months ; to the north of the continent a strong northerly component during the summer months and southerly during winter months. On the New South Wales coast the mean direction in summer is from the north-east, and in winter from the west.

On the Western Australian coast the mean direction during the summer months is from south-west to south-east, and during the winter from north-north-west to north-north-east.

Inland the mean direction of wind is largely dominated by the seasonal distribution of pressure, thus, during the winter months, when anticyclones are constantly building up pressure in the interior, there is a decided spiral contra clockwise circulation from the centre towards the coast line of the continent.

During the summer time, owing to the strong convectional action in the interior and consequently lowered pressure, the circulation is reversed and a clockwise spiral circulation obtains from the ocean to the centre of the continent. Minor factors of wind control are occasional cyclones chiefly on the east and north-west coast lines, and tornadoes which may occur in any part of Australia during the summer months, but most frequently over inland areas. These tornadoes generally develop in extensive barometric col areas or over zones where the pressure is uniform and without isobaric control, or in the north-eastern or northern gradients of cyclonic depressions moving across the southern interior of the continent, the gradients again being very slight. They generally travel on a north-north-west to south-south-east course, and at times are so strong as to level strips of country forest and destroy townships.

A north-east sea-breeze (black north-easter) is a notable feature of Sydney Harbor weather. It starts to blow about 10 a.m. on bright summer mornings, gradually increasing in force until 3 p.m., when it often reaches a velocity of 30 or 40 miles per hour ; from that hour it gradually moderates, and generally ceases with sundown. The depth of this wind is comparatively slight, and, moreover, it does *not ordinarily penetrate inland* beyond a distance of 10 to 20 miles.

13. Southerly Bursters.

Southerly bursters are a distinctive feature of summer weather on the coast of New South Wales, occurring most frequently between the months of September and February inclusive, and between the hours of 7 p.m. and midnight.

As the name implies, the wind comes suddenly from the southerly quarter, causing a fall in temperature of from 20 to 40 degrees in the 24 hours, the most rapid decline taking place during the first hour of the blow. The mean velocity is about 32 miles per hour, and many of the gusts may reach a rate of 80 miles and over per hour. The blows may last for a few hours only or for several days, the duration being dependent upon the extent of the anticyclone to the west.

Thunderstorms frequently accompany the bursts, but useful rains only occur when the centres of the high pressure are travelling in high latitudes.

The rate of translation of a burster along the coast is about 20 miles per hour, but has no relation to the velocity of the prevailing wind. A mild burster may be translated at a rate of 60 miles per hour from point to point on the coast or may occur simultaneously. On the other hand, a violent burster may be translated from place to place under a rate of 20 miles per hour.

The explanation is as follows :—

Bursters, while being undoubtedly deflected sea-breezes, occur generally with the passage of the axis of V-shaped depressions backed up by anticyclones to the west of them. The change of wind takes place from a northerly to a southerly component at the moment when the axis happens to coincide with or cross any point, but as the axes of these depressions are constantly varying in their angular relation to the coastline, it follows that the rate of translation must vary accordingly. If the axis takes the same angle as the coastline the burster occurs almost coincidently on all parts of the coast. If the axis is vertical or runs from north-west to south-east, translation is from south to north ; this is the general experience, but it has happened that the bursters have worked down the coast, owing to the axes of the depression on such rare occasions running from a south-west to a north-east direction.

Southerly bursters are most frequent during seasons of sporadic rains in the interior, and least frequent during exceptionally rainy seasons in the interior, which is strong evidence that they are a response to intense heat convectional action inland.

The average number of visitations in a season is 32, the greatest number, 58, was recorded in the year 1896, and the least, 16, in the year 1890, when vast areas of western New South Wales were under the flood waters of the Darling River.

They can always be looked for on hot days, but the most reliable attending indications are, first, the proximity of a V depression or relatively low barometers in comparison with those over Victoria. A foggy morning following a hot day is also a sure sign, and the local barometer invariably starts to rise slowly several hours before their advent. With these known facts they now rarely arrive without ample warning being given.

They are analogous to the Pamperos of Argentina.

The term " Brickfielder " now applied to hot dusty northerly winds on the gold-fields of Victoria was the first name given to southerly bursters in Sydney. They were then called brickfielders because brickfields in the early days were worked to the south of the infant city, and with the arrival of southerlies clouds of dust from these fields were brought to the northern end of the town. With the migration of citizens of Sydney to the gold-fields of Victoria half-a-century ago these miners transferred the name to the hot dusty northerlies prevailing there.

The Fremantle doctor is the name given to the local sea-breeze at the chief Western Australian port. It is a cool wind from the south-west, generally starting soon after midday during the summer months, and, of course, moderating with the declining sun.

The name of "Cock Eye Bob" is the name given to thunder squalls which occur frequently on the north-west coast of Western Australia during the summer months.

14. Hurricanes.

The two zones of Australia subject to visitations of hurricanes are the north-west coast of Western Australia and the north coast of Queensland. The hurricanes on the former are known as "willy willies," and are, perhaps, the more violent of the two. The storms occur between the months of November and April inclusive, but more frequently during January and March.

They appear to originate in the vicinity of Cambridge Gulf, or even as far east as Darwin. They then start on a parabolic course along the north-west coast line, gradually intensifying until they reach the latitudes of Condon and Cossack, where they generally reach their greatest energy and cause considerable damage to the pearling fleets as well as to property on shore. From this position on the north-west coast they then usually recurve inland, gradually expanding in dimensions, and, travelling through the Murchison and Coolgardie gold-fields, where they precipitate at times torrential rains, finally pass into the Great Bight, thence following the course of the southern depressions.

Whim Creek on the north-west coast has frequently received 10 inches of rain from the passage inland of these hurricanes. On 3rd April, 1898, 29·41 inches were registered for the 24 hours, together with a fall of 7·08 on the previous day, a total of 36·49 inches within 48 hours.

The isobaric indications are a high-pressure system over sub-tropical areas, and an incipient low on the north-west coast. When local barometers show signs of falling with an easterly wind, conditions are conducive to the development or approach of "willy willies," and precautions should be taken accordingly.

A rapid fall with increasing force of wind from the east may be regarded as a definite indication of a heavy blow.

The pearl divers affirm that 24 hours' notice is always given of the approach of these storms by a sub-ocean swell, and mariners further say that the sky assumes a pale-green aspect for a day or so before the hurricane arrives.

The hurricanes on the north-east coast occur most frequently between January and April, but occasionally they may appear as late as June. The embryo stage begins generally in the South Seas in latitude 8° or 10° S.; they follow the same parabolic course as the western hurricanes, and almost invariably strike the coast between 15° and 20° S. latitude, in which zone they exhibit their most violent phases, but they not infrequently first present themselves as far south as Brisbane, travelling thence down the east coast as far as Sydney, and finally passing off into the Tasman Sea. The rain from these hurricanes is in all cases very heavy over coastal and highland areas, over which their influence extends.

One of these hurricanes struck Port Douglas on 16th March, 1911· Besides the loss of two lives it practically destroyed the township, together with all the meteorological equipment, so that no local rain was recorded, but at South Mosman, 8 miles distant, the total rain registered in 24 hours was 16·10 inches, while during a similar visitation towards the end of the month, over 63 inches fell at the same place in five days, distributed as follows:—3·44 on 30th; 9·00 on 31st; 31·53 on 1st April; 13·74 on 7th; and 5·64 on the 3rd. During the fall of the 31·53 inches the following measurements were recorded:—8·28 inches in 7½ hours, 9·70 in 3 hours, 3·93 in 2 hours, and 9·62 in 11½ hours.

The Admiralty Hydrographic Office, in 1897, published the following remarks and advice concerning tropical hurricanes on the Queensland coast:—

Tropical hurricanes on the coast of Queensland may be expected during the summer months, namely, December, January, February, March, and the early part of April. These storms appear to originate between latitudes 8° to 12° S., and between the meridians of 155° E. and 170° W. On reaching the Queensland coast they may strike the land at any point between latitudes 12° and 26°—that is, between Cape Grenville and Wide Bay. To the southward of latitude 26° S. these storms break up into heavy gales. If, during the summer months, and the early part of April, a heavy swell sets in from north-east, and there is little or no wind at the time, bad weather is certain, for the sea always is in advance of a cyclone. With the glass steadily falling, heavy rains, and murky sky, winds between south-south-east and east a cyclone may be expected. These storms may extend some distance inland, but their centres do not often pass the coastal ranges, which appear to repel them, and they usually emerge from the coast between Broadsound and Cape Moreton. If the barometer is high over a considerable portion of the coast, the storm will recurve some distance off the land, and the wind will be from south-east to south. If, on the contrary, the barometer is low in front of the storm, it will blow home on the land as far as the coast range, and cause floods. When this happens the first of the gale will be southerly, the latter part northerly. The bearing of the storm centre will be at right angles with the waves line. Thus, on a fine day if there is a heavier sea than usual breaking on the beach, and it is coming from the north-east, if the direction remains the same or nearly so, and the barometer is not above 30 inches, the gale will blow home on the land, and the first signs of bad weather will not precede the gale by more than 12 hours, but if the direction of the swell changes to the eastward the storm is recurving, and the body of it will not reach the land. When the swell is from the east the storm centre is past; when there is anything southing in the line of the swell the storm has passed. No matter how threatening the weather signs may be, if the line of swell comes first from the southward, there will be only an ordinary south polar storm, with a low temperature.

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